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NATIONAL DAM SAFETY PROGRAM. CLINTON RESERVOIR DAM (NJ 00314) P--ETC(U)
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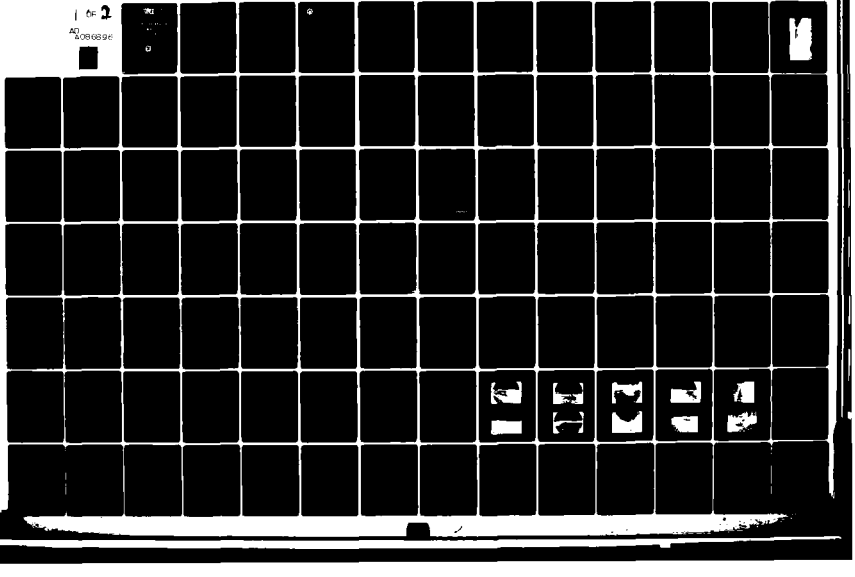

LEVEL II

PASSAIC RIVER BASIN
CLINTON BROOK, PASSAIC COUNTY
NEW JERSEY

CLINTON RESERVOIR DAM NJ 00314

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

APRIL 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-H

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

10 JUL 1980

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Clinton Reservoir Dam in Passaic County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Clinton Reservoir Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 58 percent of the Probable Maximum Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

c. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Observation wells or piezometers should be installed in the embankment and the spillway discharge channel to determine the location of the phreatic surface and the paths of the seepage observed.

(2) The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

(3) All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection.

(4) Remove vegetation from the downstream channel.

d. Within one year from the date of approval of this report, repair the crack across the spillway, replace the missing boulders in the right abutment masonry wall and regrout the wall.

e. Within two years from the date of approval of this report, consider providing additional low-level outlet facilities to decrease the draw down time.

f. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Roe of the Eighth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-N
Honorable Brendan T. Byrne

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

CLINTON RESERVOIR DAM (NJ00314)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 14 November, 4 and 15 December 1979 by Harris - ECI Associates, Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Clinton Reservoir Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 58 percent of the Probable Maximum Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

c. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Observation wells or piezometers should be installed in the embankment and the spillway discharge channel to determine the location of the phreatic surface and the paths of the seepage observed.

(2) The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

(3) All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection.

(4) Remove vegetation from the downstream channel.

d. Within one year from the date of approval of this report, repair the crack across the spillway, replace the missing boulders in the right abutment masonry wall and regrout the wall.

e. Within two years from the date of approval of this report, consider providing additional low-level outlet facilities to decrease the draw down time.

f. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 JULY 1980

PASSAIC RIVER BASIN

CLINTON BROOK, PASSAIC COUNTY

NEW JERSEY

CLINTON RESERVOIR DAM

NJ00314

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PHILADELPHIA, PENNSYLVANIA 19106

APRIL 1980

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name:	Clinton Reservoir Dam, I.D. NJ 00314
State Located:	New Jersey
County Located:	Passaic County
Stream:	Clinton Brook
River Basin:	Passaic River
Date of Inspection:	November 14, December 4 and 15, 1979

Assessment of General Conditions

Clinton Reservoir Dam is an earthfill dam containing a broad crested concrete weir spillway at the left end of the dam. The overall condition of the dam is good. There is no major sign of distress or instability in the embankment. There are boulders missing from the right abutment masonry wall and the abutment wall also needs to be regrouted. The downstream channel is well defined. The operation of the low-level outlet was demonstrated satisfactorily. The hazard potential is rated as "high".

The adequacy of Clinton Reservoir Dam is considered questionable in view of its lack of spillway capacity to pass the SDF (PMF) without overtopping the dam. The spillway is capable of passing a flood equal to 57 percent of the PMF, and is assessed as "inadequate".

At present, the engineering data available is not sufficient to make a definitive statement on the stability of the dam, but based on the findings of the visual inspection, the preliminary assessment of static stability is that it is satisfactory. The following actions are recommended along with a timetable for their completion. All recommended actions should be conducted under the supervision of an Engineer who is experienced in the design, construction and inspection of dams.

1. Carry out a more precise hydrologic and hydraulic analysis of the dam within twelve months, to determine the need and type of mitigating measures necessary. Based on the results of these studies remedial measures should be instituted. This should include the installation of a tailwater gage.

2. Observation wells or piezometers should be installed in the embankment and spillway discharge channel to determine the location of the phreatic surface and the paths of the seepage observed. This should be done within twelve months.

3. The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

4. Repair the crack across the spillway; replace the missing boulders in the right abutment wall and regrout the wall. This work should be completed within twelve months.

5. All brush and trees should be removed from the downstream and upstream slopes to avoid problems which may develop from roots. The embankment face should then be seeded to develop a growth of grass for surface erosion protection. This program should be started within twelve months.

6. Remove vegetation from downstream channel within twelve months.

7. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

Furthermore, while of a less urgent nature, the following additional action is recommended and should be carried out within twenty-four months.

1. Consider providing additional low-level outlet facilities to decrease drawdown time.

2. Conduct a complete topographic survey of the dam and surrounding area, in order to develop a detailed plan and several cross-section of the dam. Annotate and update the existing drawings, and form a coherent as-built set.

3. The owner should develop, within one (1) year after formal approval of the report, written operating procedures and a periodic maintenance plan to insure the safety of the dam.

John P. Talerico, P.E.
HARRIS-ECI ASSOCIATES

Photo taken on February 15, 1980

C L I N T O N R E S E R V O I R D A M

View, from spillway, toward right end of dam. Valve House is visible at left center. Note riprap on both the downstream, bottom left, and the upstream, bottom

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

CLINTON RESERVOIR DAM, I.D. NJ 00314

S E C T I O N 1

1. PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn, is contracted to the Philadelphia District of the Corps of Engineers, and was carried out by the engineering firm of Harris-ECI Associates, Woodbridge, New Jersey.

b. Purpose of Inspection

The visual inspection of Clinton Reservoir Dam was made on November 14, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observation made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

1.2 Description of Project

a. Description of Dam and Appurtenances

Clinton Reservoir Dam is an earthfill dam about 1,530 feet long and 55 feet high with a concrete core wall. There is a 300-foot wide broad crested concrete weir spillway at the dam's left end. The crest of the spillway is 5.5 feet below the top of the dam. The embankment crest has a width of 18 feet with its upstream and downstream slopes being 2H:1V. A 16-foot wide berm upstream and a 12-foot wide berm downstream intercept the slopes 6 feet from the embankment crest. Riprap protection has been placed on the embankment's entire upstream slope and on the downstream slope from the berm to its toe.

The low-level outlet consists of an arch-shaped tunnel under the embankment. The tunnel is cut through rock and it is located about 140 feet from the dam's right end. The flow through the tunnel is controlled by four cone valves having 8, 10, 12 and 14 inch diameters. Four 42-inch diameter cast iron pipes are at both the upstream side and the downstream side of the valves. These pipes are connected to the four cone valves by the use of reducers and increasers. Stems from the valves extend up into a brick Valve House where two of the valves are operated by handwheels and the remaining two are operated by cranks. According to Plate 4, the upstream side of the tunnel is screened. The tunnel outlet exits at the embankment's toe of slope. From this point the flow passes into a channel cut out of rock. This flow joins with the spillway's flow about 1,000 feet from the spillway. The flow, known as Clinton Brook, passes under Clinton Road about 1,300 feet from the spillway.

b. Location

Clinton Reservoir Dam is located on Clinton Brook in the Township of West Milford, Passaic County, New Jersey. It is accessible by way of Clinton Road.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineers, the dam is classified in the dam size category as being "intermediate", since its storage volume of 14,272 acre-feet is more than 1,000 acre-feet, but less than 50,000 acre-feet. The dam is also classified as "intermediate" because its height of 55.5 feet is greater than 40 feet but less than 100 feet. The overall size classification of Clinton Reservoir Dam is classified as "intermediate" in size.

d. Hazard Classification

A hazard potential classification of "high" has been assigned to the dam on the basis that a hypothetical failure would result in excessive damage to Clinton Road immediately downstream of the dam. There are also three houses, LaRue Road and N.J. Route 23 further downstream of the dam. Because these three roads are heavily traveled and because the three houses are occupied, the possibility exists of the loss of more than a few lives in the event of dam failure.

e. Ownership

Clinton Reservoir Dam is owned by:

City of Newark
Department of Public Works
Division of Water Supply
1294 McBride Avenue
Little Falls, N.J. 07424

Attention: Mr. Daniel Berardinelli
(201) 265-4965

f. Purpose

Clinton Reservoir Dam is presently used as a storage reservoir for the water supply sustem.

g. Design and Construction History

Clinton Reservoir Dam was constructed in the early 1890's. Plans showing the original design are available but no design criteria or construction report could be found.

h. Normal Operating Procedures

Clinton Reservoir is a primary storage reservoir for the City of Newark Water Supply System. It is one of the five storage reservoirs that is drawndown in sequence in order to permit filling of all the reservoirs in a uniform manner during rainfall.

1.3 Pertinent Data

a. Drainage Area	9.10 sq. mi.
b. Discharge at Dam Site	
Ungated spillway capacity at elevation of top of dam:	10,448 cfs (997.50 NGVD)
Total spillway capacity at maximum pool elevation (SDF):	23,352 cfs (999.26 NGVD)
c. Elevation (Feet above NGVD)	
Top of dam:	997.50
Maximum pool design surcharge (SDF):	999.72
Recreation pool:	N/A
Spillway crest:	992.00
Streambed at centerline of dam:	942.0 (estimated)
Maximum tailwater:	951.5 (estimated)
d. Reservoir	
Length of maximum pool:	9,500 ft. (estimated)
Length of normal pool:	9,000 ft. (estimated)
e. Storage (acre-feet)	
Spillway crest:	10,796
Top of dam:	13,372
Maximum pool (SDF):	14,272
f. Reservoir Surface (acres)	
Top of dam:	507 (estimated)
Maximum pool (SDF):	546 (estimated)
Spillway crest:	405 (992 NGVD)

g. Dam

Type:	Earthfill with concrete core
Length:	1,530.0 ft. (effective)
Height:	55.5 ft.
Top width:	18 ft.
Side slopes - Upstream:	2H:1V
- Downstream:	2H:1V
Zoning:	Unknown
Impervious core:	Concrete - 5.0 to 5.4 ft. wide
Cutoff:	None
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel

N/A

i. Spillway

Type:	Broad crest weir
Length of weir:	300 ft.
Crest elevation:	992.0 NGVD
Gates:	None
U/S Channel:	Clinton Reservoir
D/S Channel:	The channel from the spillway meets the channel from the tunnel under the Value House approximately 1,000 feet from spillway.

j. Regulating Outlets

Low level outlet:	4 - 42 inch cast iron pipes with 8,10,12, and 14 inch cone valves.
Controls:	4 manually operated cone valves
Emergency gate:	Same as above.
Outlet:	950 NGVD

SECTION 2

2. ENGINEERING DATA

2.1 Design

Drawings for the original construction of Clinton Reservoir Dam in the early 1890's and the modifications in 1960, are available from the City of Newark, Division of Water Supply, offices on McBride Avenue in Little Falls, N.J. One of these drawings shows that the concrete core wall is founded on rock; and it also shows the rock profile. No data from soil borings, soil tests, or other geotechnical data is available. Data concerning the hydraulic capacity of the spillway is also unavailable.

2.2 Construction

Data is not available concerning the as-built construction of the dam. No data exists of the construction methods, borrow sources, or other data pertinent to the construction of the dam.

2.3 Operation

Daily records have been kept since 1972 of the water level in the reservoir. The water level indicator was inspected and found in satisfactory condition.

According to the City of Newark's Division of Water Supply, five storage reservoirs, of which Clinton Reservoir is a primary one, are utilized for their supply system. Basically, the five reservoirs are utilized in sequence in order to permit filling of all reservoirs uniformally during rainfall. Looking downstream, from North to South, Clinton Reservoir is located number 2 in the five-reservoir system.

2.4 Evaluation

a. Availability

The availability of engineering data is fair. The drawings and verbal information concerning the original construction and the subsequent modifications can be obtained from the Manager's Office, Division of Water Supply, listed above under Section 2.1.

b. Adequacy

The engineering data available, together with that obtained in the field, were adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform a stability analysis, but preliminary evaluation could be made based on visual observations.

c. Validity

Information contained in the drawings and checked by limited field measurements appears to be valid. However, field investigation revealed no riprap on the embankment's downstream side slope from the top of the embankment to the berm. See Plate 4.

SECTION 3

3. VISUAL INSPECTION

3.1 Findings

a. General

The visual inspection of Clinton Reservoir Dam revealed the dam and spillway to be in good condition, but in need of minor repairs. The lake level was below the spillway's crest at the time of the inspection.

b. Dam

The earth embankment appears sound. No surface cracking on the embankment or at the toe was noted. No sloughing or erosion of the embankment and abutment slopes were visible. No misalignment of the embankment in the horizontal or vertical plane was evident. No rip-rap failures were noted. Minor seepage, running clear, was noticed at the downstream toe of the embankment. The seepage is located at a point that is about 400 feet from the Valve House, toward the spillway, and the location appears to be at the "Bed of Old Brook" shown on Plate 3. The embankment is clear of vegetation but there are a few trees growing on its side slopes. No evidence of burrowing by animals was observed.

c. Appurtenant Structures

1. Spillways

The broad crest weir spillway was in fair condition. The vertical and horizontal alignment of the crest was good. A transverse crack exists across the spillway. There is vegetation growing on the downstream side of the spillway. Boulders were missing from the right abutment masonry wall and the abutment wall also needed re-grouting. Leakage was noticed in the downstream channel of the spillway. The channel is riprapped.

2. Outlet Works

There are four 42-inch diameter cast iron pipes underneath the Valve House. The pipes, in good condition, discharge their flow into a tunnel cut through rock underneath the embankment. The tunnel is arch-shaped, about 12 feet high and about 24 feet wide at its base, and in good condition.

d. Reservoir Area

The reservoir has moderate to steep side slopes. There is no indication of slope instability.

e. Downstream Channel

Two downstream channels exist - one from the spillway and the other from the tunnel underneath the embankment. These channels meet approximately 1,000 feet from the spillway. Both channels are in good condition.

The channel receiving the flow from the tunnel is cut through rock and leakage was noticed on both banks of the channel near the tunnel. The tunnel is in good condition.

Approximately 300 feet downstream from where the two channels meet, or about 1,300 feet from the spillway, the channel crosses under Clinton Road. One house, located approximately one mile from the spillway, is situated on the channel's left bank near LaRue Road. Two houses, located about 7,000 feet from the spillway at LaRue Road, are situated on the channel's right bank. The channel crosses under N.J. Route 23 about 2 miles from the spillway.

f. Geology

A visual inspection of geologic features shows shale exposed at both embankment ends. The shale is gray in color, with evidence of slatey cleavage that fractures when exposed into pencil-shaped pieces. It also appears to contain traces of coarser material. The presence of this material does not appear to change its structure enough to vary its permeability or alter its integrity.

At the toe of the slope of the broad crested weir, a massive rock was noted. Access to it was difficult but its most noteworthy feature was the presence of secondary quartz filling the joints. The rock appears sound though with only little physical or chemical weathering.

The bedding generally strikes N 55 E and dips 65° - 70° throughout the site. There are two, or possibly three joint sets in evidence. One set, striking N 55° E and varying 30° - 38° N in dip appears both in the low-level outlet tunnel beneath the embankment and the left dam end. Another set, which may be two distinct sets, had the following attitudes of lineation.

Tunnel	N 35° W	$\sim$ V
Left end of dam	N 55° W	60° S

SECTION 4

4. OPERATIONAL PROCEDURES

4.1 Procedures

Clinton Reservoir Dam is a primary storage reservoir for the City of Newark's water supply system. According to their Division of Water Supply, Clinton Reservoir Dam is one of five storage reservoirs. Basically, the five reservoirs are utilized in sequence in order to permit filling of all reservoirs uniformally during rainfall.

4.2 Maintenance of the Dam

Persently, there is no regular inspection and maintenance program for the dam and appurtenant structures. Spot maintenance is performed on the valve, or gate, house and appurtenant structures but there is no routine maintenance for riprap stability, reservoir and stream cleaning.

4.3 Maintenance of Operating Facilities

The low-level outlet operating facilities consist of four manually operated cone valves and one water level indicator. At the time of inspection all four valves and the water level indicator were satisfactorily demonstrated. A flap gate is attached to each of the four pipes, at the upstream end of the pipe, opposite the cone valves. According to the owner, the flap gates operate satisfactorily and that a gate is closed when the valve online needs repairing.

4.4 Evaluation

The present operation and maintenance procedures are good with the dam and spillway being maintained in a serviceable condition.

SECTION 5

5. HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The drainage area above Clinton Reservoir Dam is approximately 9.10 square miles. A drainage map of the watershed of the dam site is presented on Plate 1, Appendix D.

The topography within the basin is flat to moderately sloped. Elevations range from approximately 1,420 feet above NGVD at the north part of the watershed to about 998 feet at the dam site. Land use patterns within the watershed are mostly woodland.

The evaluation of the hydraulic and hydrologic features of Clinton Reservoir was based on criteria set forth in the Corps' guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The SDF for the dam is the PMF.

The probable maximum flood (PMF) was calculated from the probable maximum precipitation using Hydrometeorological Report No. 33 with standard reduction factors. Due to the small drainage area, the SCS triangular hydrograph transformed to a curvilinear hydrograph was adopted for developing the unit hydrograph, with the aid of the HEC-1DB Flood Hydrograph Computer Program.

Initial and infiltration loss rates, were applied to the Probable Maximum Precipitation to obtain rainfall excesses. The rainfall excesses were applied to the unit hydrograph to obtain the PMF and various ratios of the PMF utilizing program HEC-1DB.

The SDF peak outflow calculated for the dam is 23,352 cfs. This value is derived from the PMF, and results in overtopping of the dam, assuming that the reservoir was originally at the spillway crest elevation.

The stage outflow relation for the spillway was determined from the geometry of the spillway and dam, utilizing HEC-1DB program.

The reservoir stage-storage capacity relationship to the spillway level was obtained from the City of Newark, Division of Water Supply. The reservoir stage-storage capacity relationship beyond the spillway level was computed directly by the conic method, utilizing the HEC-IDB program. The reservoir surface area at the elevations beyond the spillway level was measured by planimeter from a U.S.G.S. Quadrangle topographic map. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve was based on the assumption that the dam remains intact during routing.

Drawdown calculations indicate that to empty the reservoir to an elevation of 950.0 NGVD through the four low-level cone valves would take 37 days, assuming a 2 c.f.s./square mile inflow. This is considered to be an excessive drawdown period and provision of additional outlets should be considered.

b. Experience Data

Records of the daily reservoir stage level have been maintained since 1972. The reservoir water level is usually at 992 NGVD. There have only been a few occasions of the reservoir level being recorded higher than 992 NGVD and none of the water level exceeding 997.5 NGVD.

c. Visual Observation

Two downstream channels exist - one from the spillway and the other from the tunnel underneath the embankment. These channels meet approximately 1,000 feet from the spillway. Both channels are in good condition.

The channel receiving the flow from the tunnel is cut through rock and leakage was noticed on both banks of the rock channel near the tunnel.

Approximately 300 feet downstream from where the two channels meet, or about 1,300 feet from the spillway, the channel crosses under Clinton Road.

The slopes of the reservoir are moderate to steep and do not exhibit signs of instability. The drainage area is wooded and moderately flat sloped.

d. Overtopping Potential

A storm of magnitude equivalent to the SDF would cause overtopping of the dam to a height of 1.76 feet. Computations indicate that the dam can pass approximately 57 percent of the PMF without overtopping the dam crest. Since the PMF is the Spillway Design Flood (SDF) for this dam, according to the "Recommended Guidelines for Safety of Dams" by the Corps of Engineers, the spillway capacity of the dam is assessed as "inadequate".

SECTION 6

6. STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There are no major signs of distress in the embankment of the Clinton Reservoir Dam. Trees growing on the embankment sides could pose a threat to stability. Seepage was observed at three locations. One location is about 400 feet left of the Valve House, the second location was in the spillway discharge channel, and the third location was in the banks of the channel from the outlet tunnel. The seepage has not been monitored and no information was uncovered concerning their duration or flow rates. No evidence of burrowing animals was observed. The spillway is in good condition but the right abutment masonry wall needs repairs.

b. Design and Construction Data

No design computations relating to stability were uncovered during the report preparation phase. No embankment or foundation soil parameters are available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction are available for use in the stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam. The dam and spillway have served satisfactorily since its construction in the early 1890's.

d. Post-Construction Changes

The Valve House was built in 1960.

e. Static Stability

A static stability analysis was not performed for Clinton Reservoir Dam because the lack of data on which to base assumptions of material properties within embankment zones might produce misleading results, but based on the findings of the visual inspection, the preliminary assessment of static stability is that it is satisfactory.

f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers. In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist, and based on the findings of the visual inspection, the preliminary assessment of the static and seismic stabilities is that they are satisfactory.

SECTION 7

7. ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase I report.

The safety of Clinton Reservoir Dam is in question because the dam does not have adequate spillway capacity to pass the SDF which is the PMF without overtopping. Overtopping of the dam carries with it the danger of possible progressive failure of the dam. The dam's present spillway capacity is about 57 percent of the PMF.

No definitive statement pertaining to the safety of the embankment can be made without acquisition of embankment material engineering properties, but based on the findings at the visual inspection, the preliminary assessment of static stability is that it is satisfactory.

b. Adequacy of Information

The information uncovered was adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform even an approximate computation of the dam's stability. A preliminary assessment of the dam could be made by visual observation only.

c. Urgency

The remedial measures and recommended actions along with a timetable for their completion are detailed below. All recommended action should be conducted under the supervision of an engineer who is experienced in the design, construction and inspection of dams.

7.2 Remedial Measures

a. Alternatives for Increasing Spillway Capacity

Alternatives for increasing spillway capacity are as follows:

1. Increase the embankment height, thus permitting a higher discharge to pass over the spillway and reducing the possibility of overtopping.

2. Lower the spillway crest elevation.

3. Increase the effective spillway crest length.

4. A combination of any of the above alternatives.

b. Recommendations

1. Carry out a more precise hydrologic and hydraulic analysis of the dam within twelve months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop alternative schemes for construction. This should include the installation of headwater and tailwater gages. The ability of the dam to withstand overtopping should also be studied.

2. Observation wells or piezometers should be installed in the embankment and the spillway discharge channel to determine the location of the phreatic surface and the paths of the seepage observed. This should be done within twelve months.

3. The flow of seepage should be monitored monthly to determine its volume and whether it presents a problem to the safety of the dam.

4. Repair the crack across the spillway, replace the missing boulders in the right abutment masonry wall and regrout the wall. This work should be completed within twelve months.

5. All trees and brush should be removed from the side slopes to avoid problems which may develop from roots. The embankment face should then be reseeded to develop a growth of grass for surface erosion protection. This program should be started within twelve months.

6. Remove vegetation from the downstream channel within twelve months.

The following additonal actions are recommended:

1. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

2. Consider providing additional low-level outlet facilities to decrease the drawdown time.

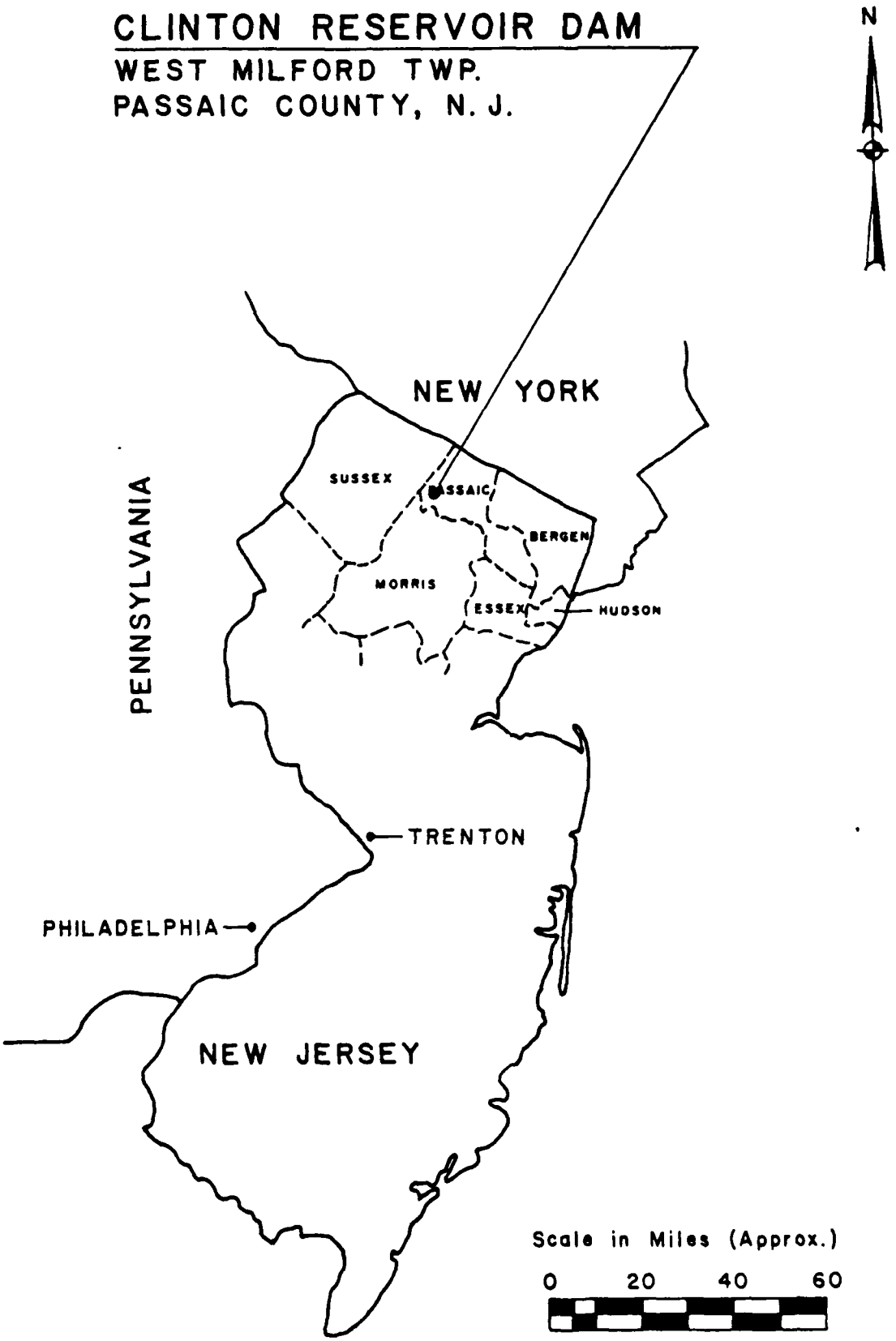
c. O & M Procedures

The owner should develop, within one (1) year after formal approval of the report, written, operating procedures and a periodic maintenance plan to insure the safety of the dam.

PLATES

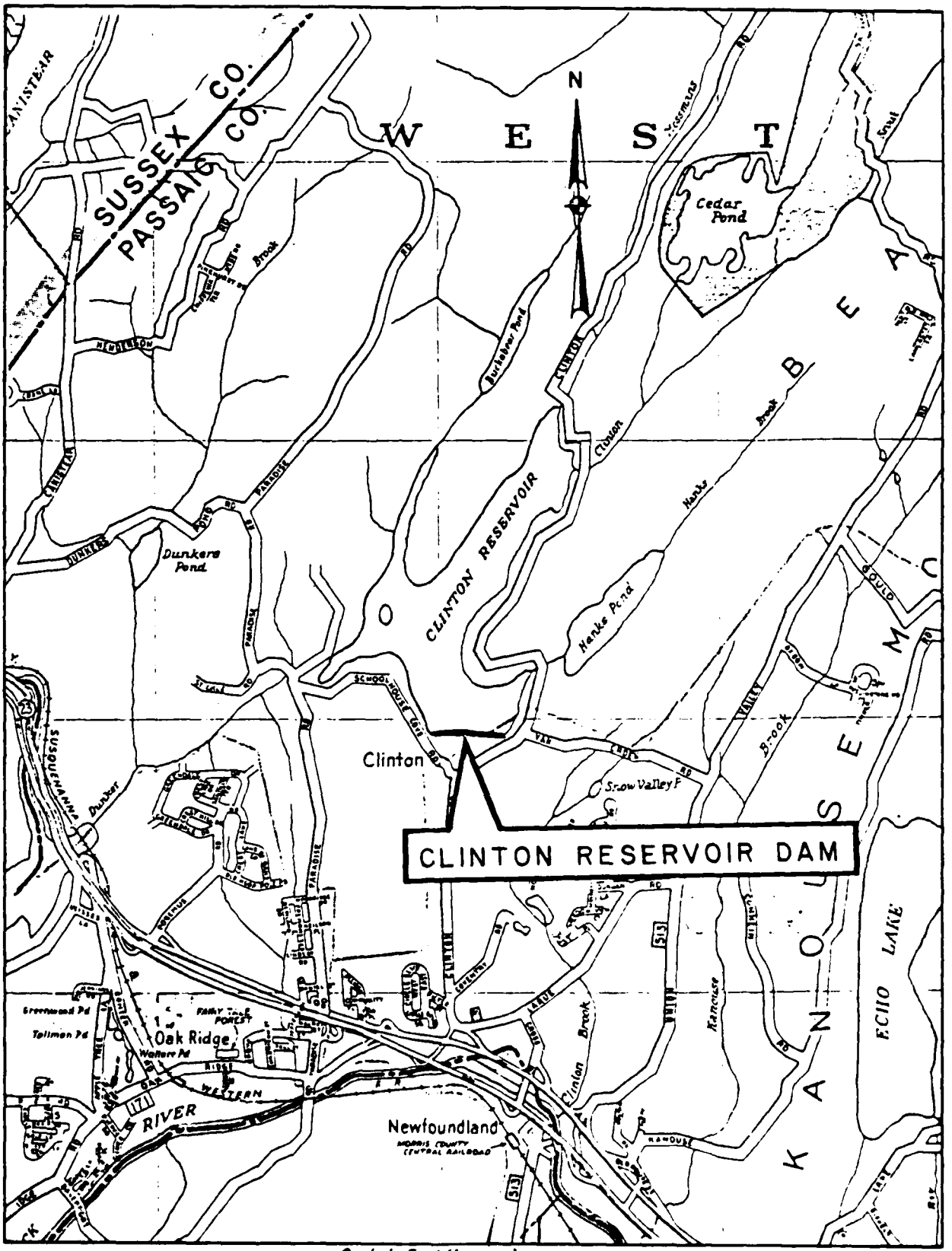
CLINTON RESERVOIR DAM

WEST MILFORD TWP.
PASSAIC COUNTY, N. J.



KEY MAP

PLATE 1

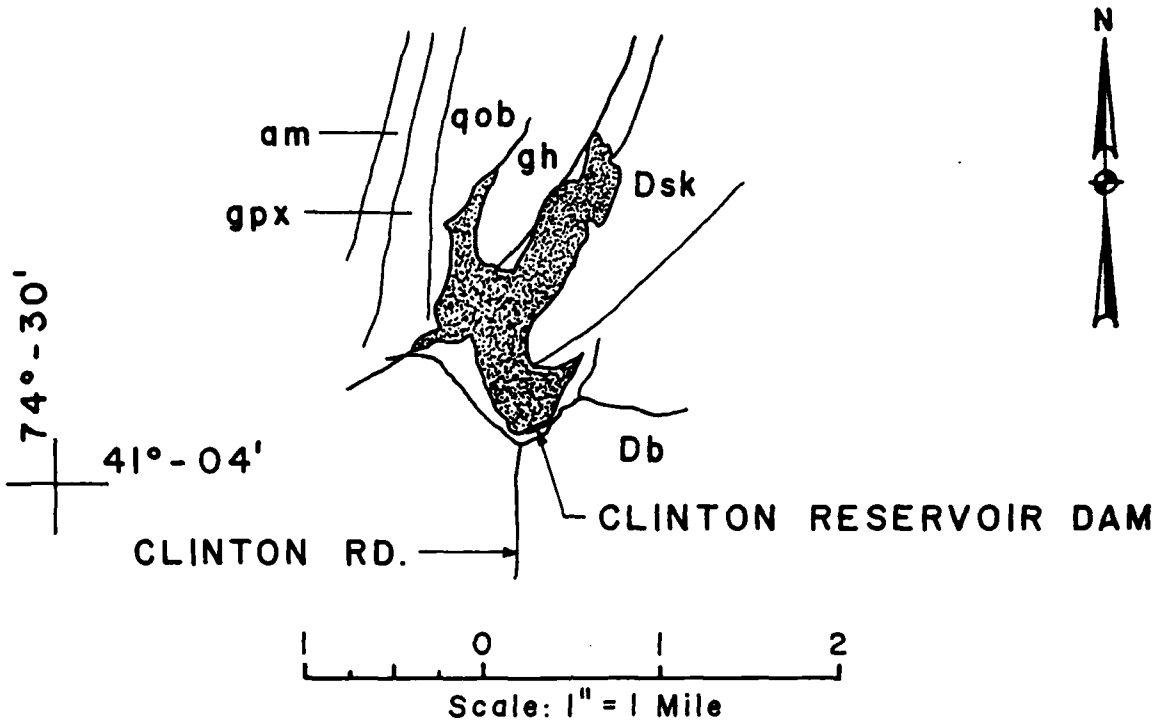


Scale in Feet (Approx.)

2,000 0 2,000 4,000 6,000 8,000 10,000

VICINITY MAP

PLATE IA



LEGEND:

DEVONIAN

Db Bellvale Sandstone

Dsk Skunnemuck Conglomerate

PRECAMBRIAN

am Amphibolite

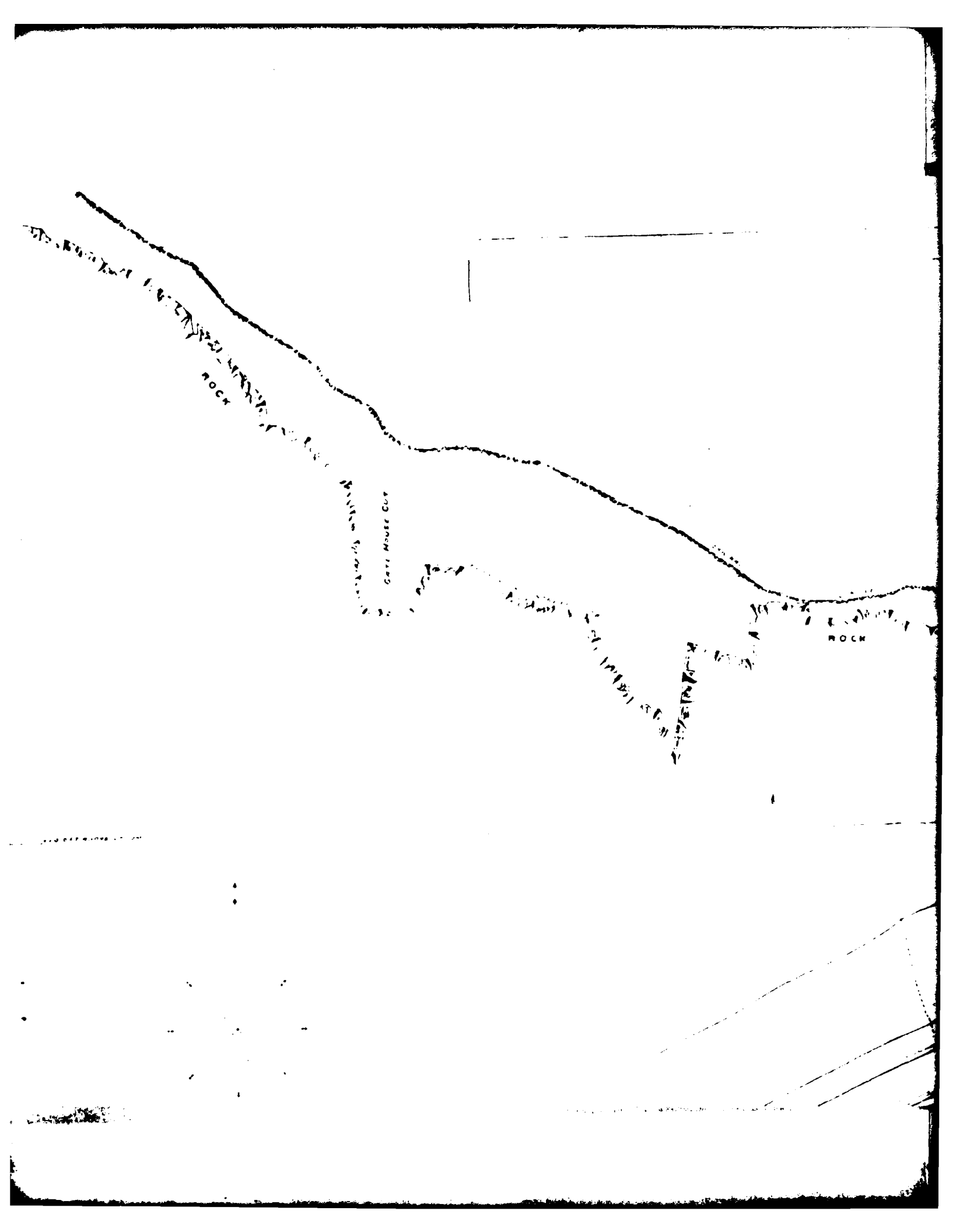
gh Mostly Hornblende Granite and Gneiss

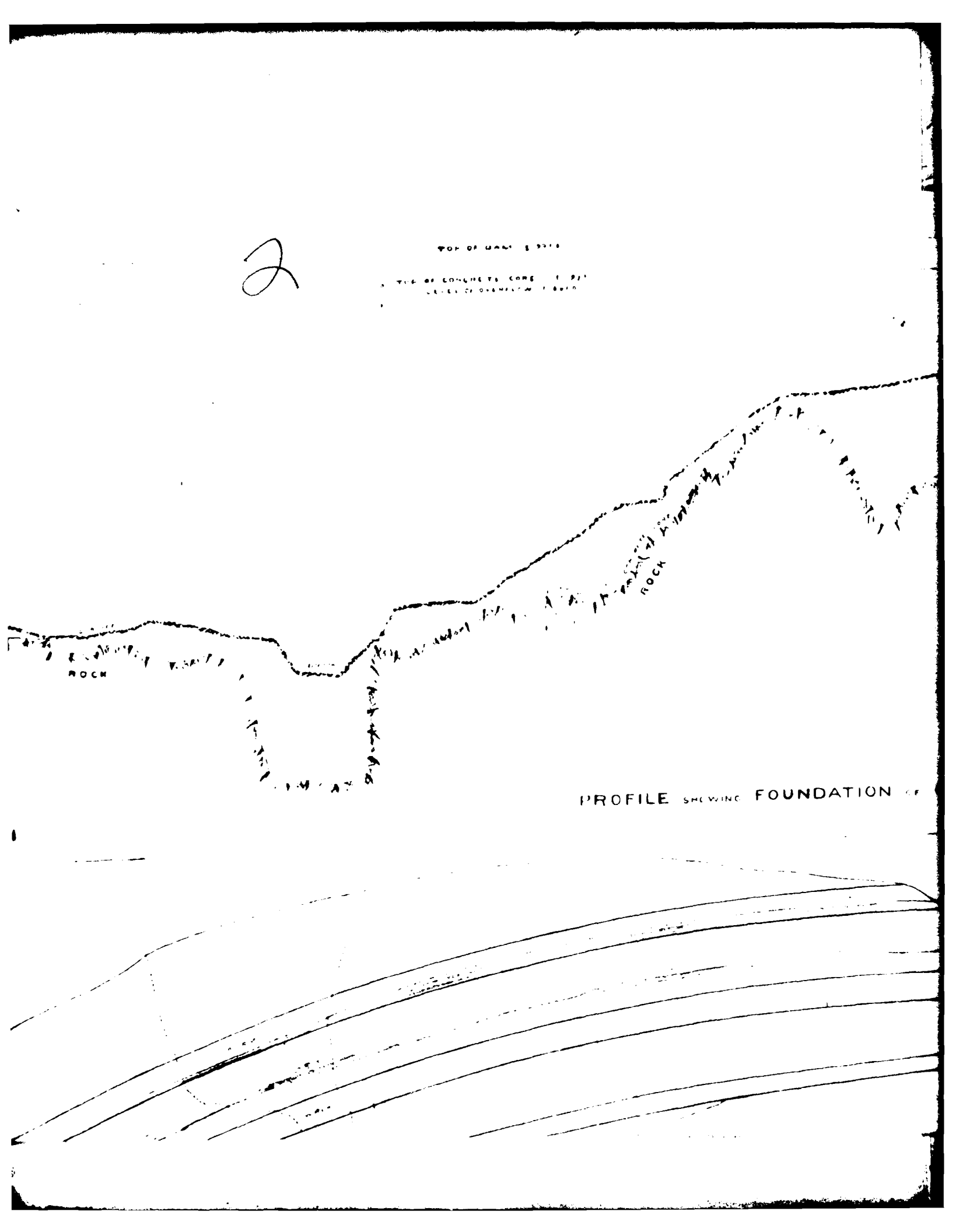
qob Quartz-Oligoclase-Biotite Gneiss

gpx Pyroxene Gneiss

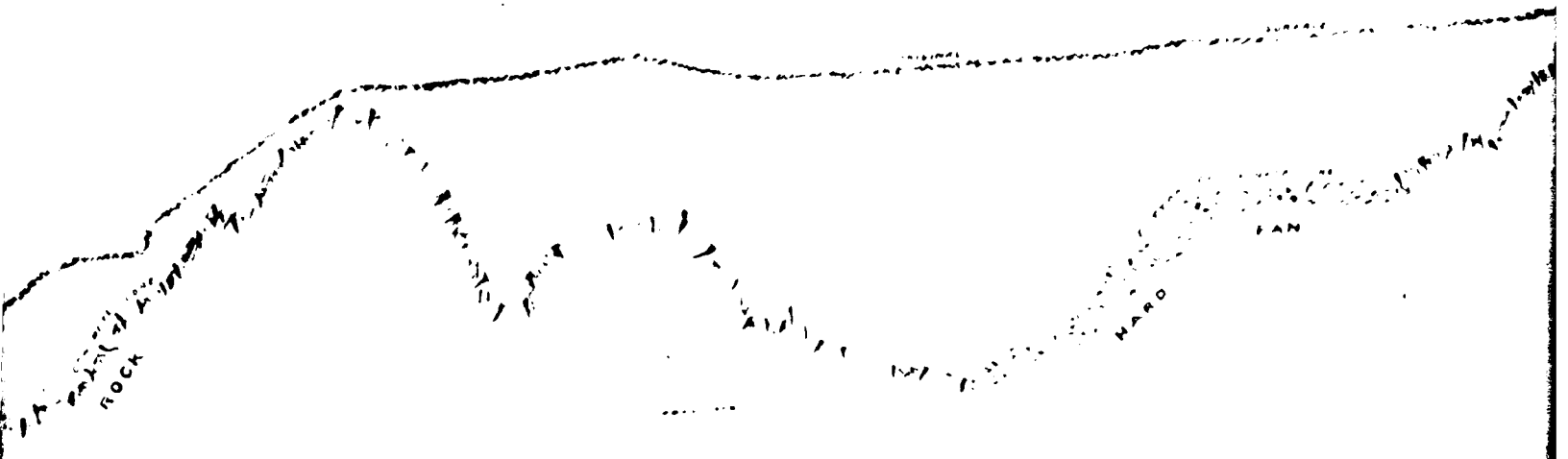
GEOLOGIC MAP
CLINTON RESERVOIR DAM

PLATE 2

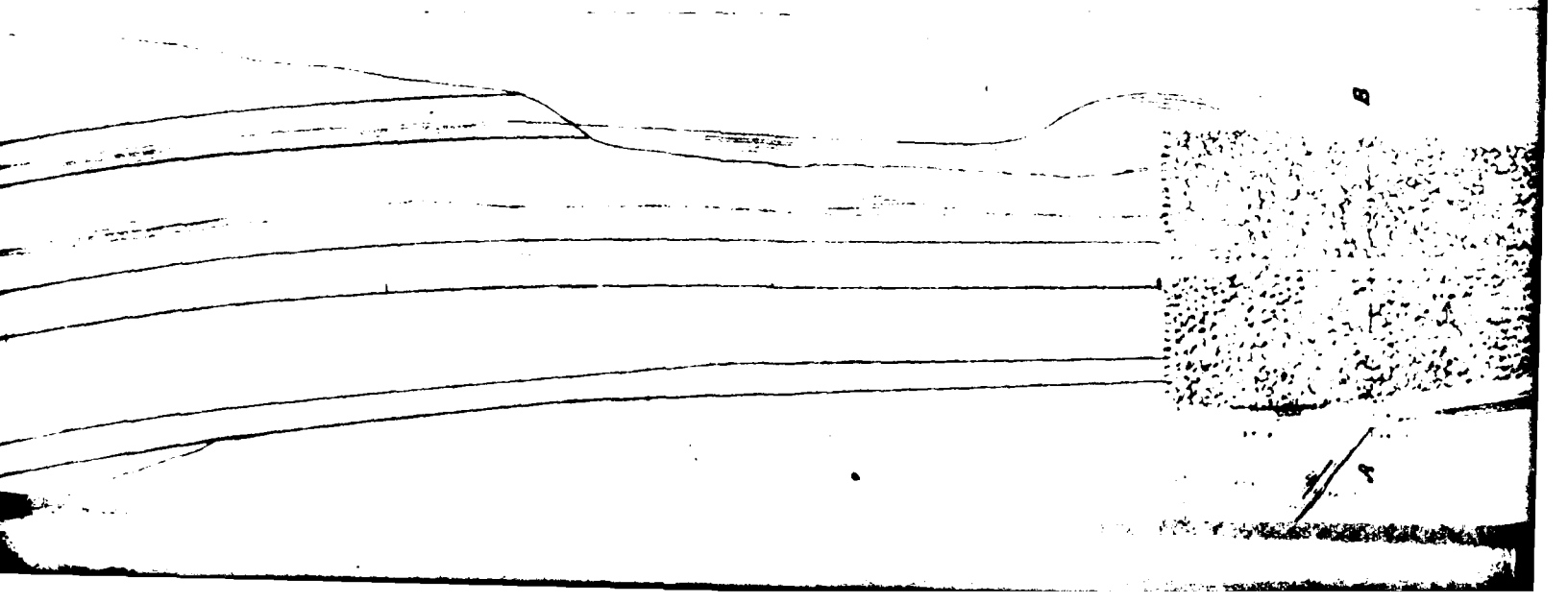

ROCK
GATE HOUSE CUT
ROCK

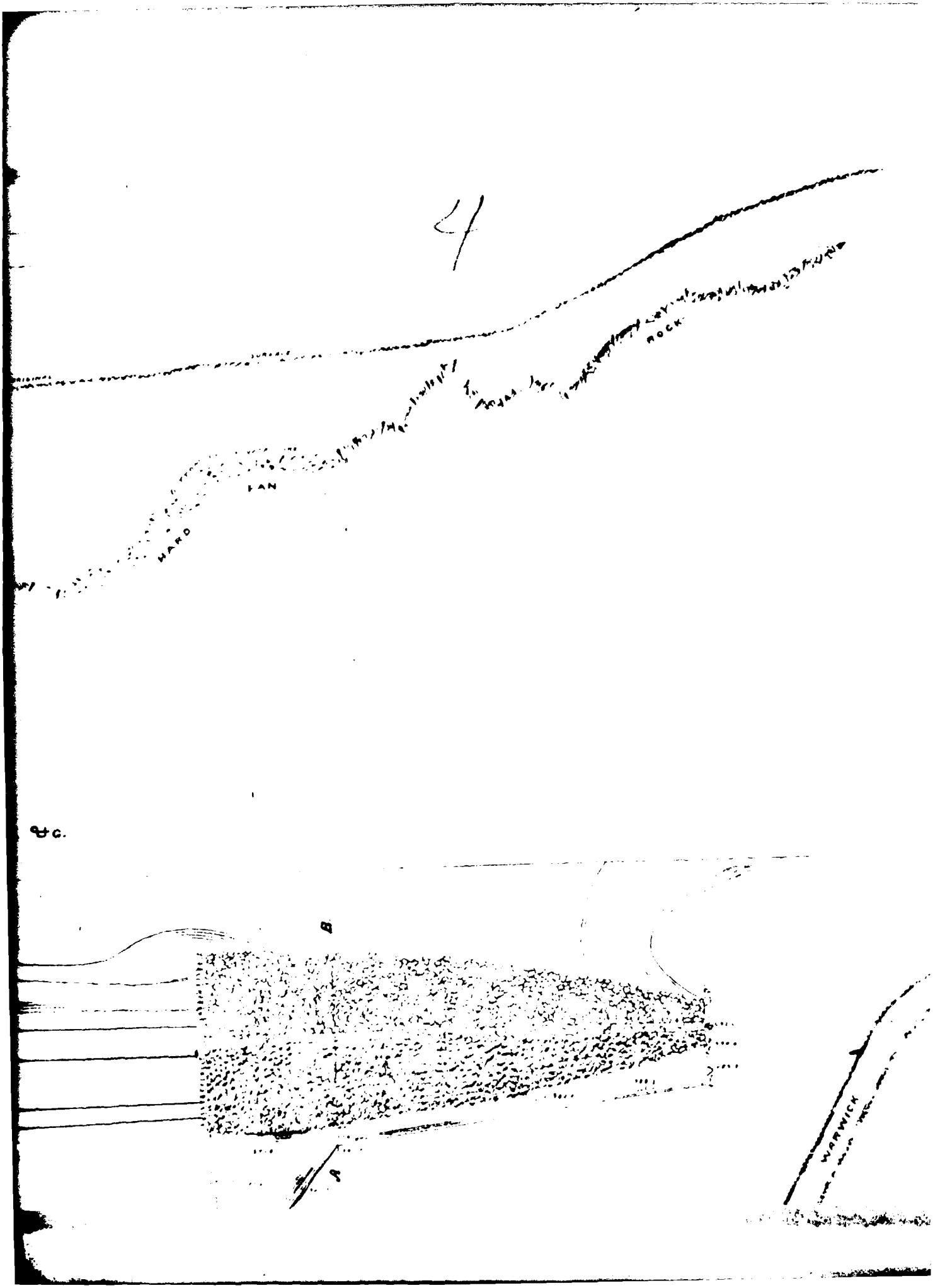

ROCK
ROCK
PROFILE SHOWING FOUNDATION

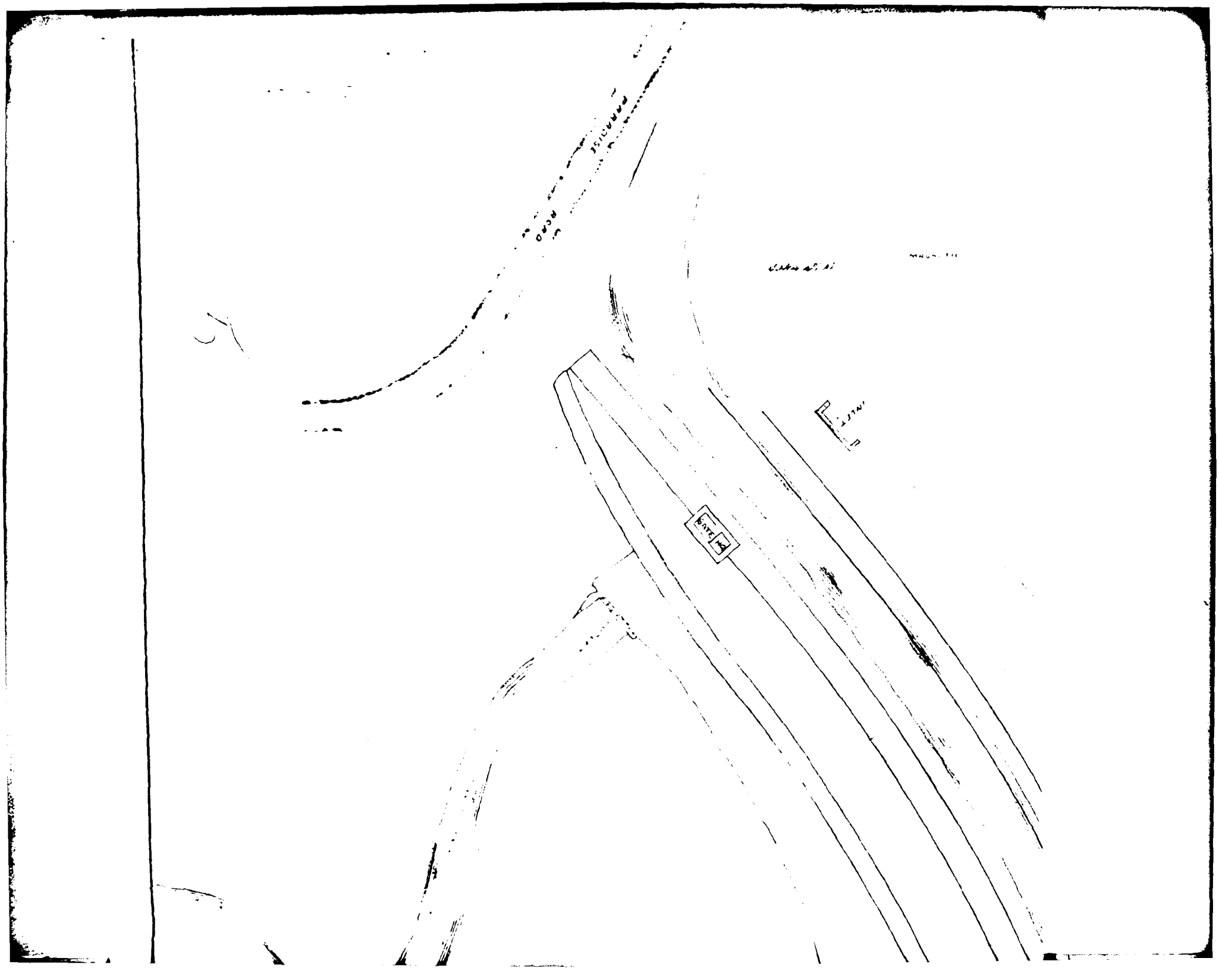
3

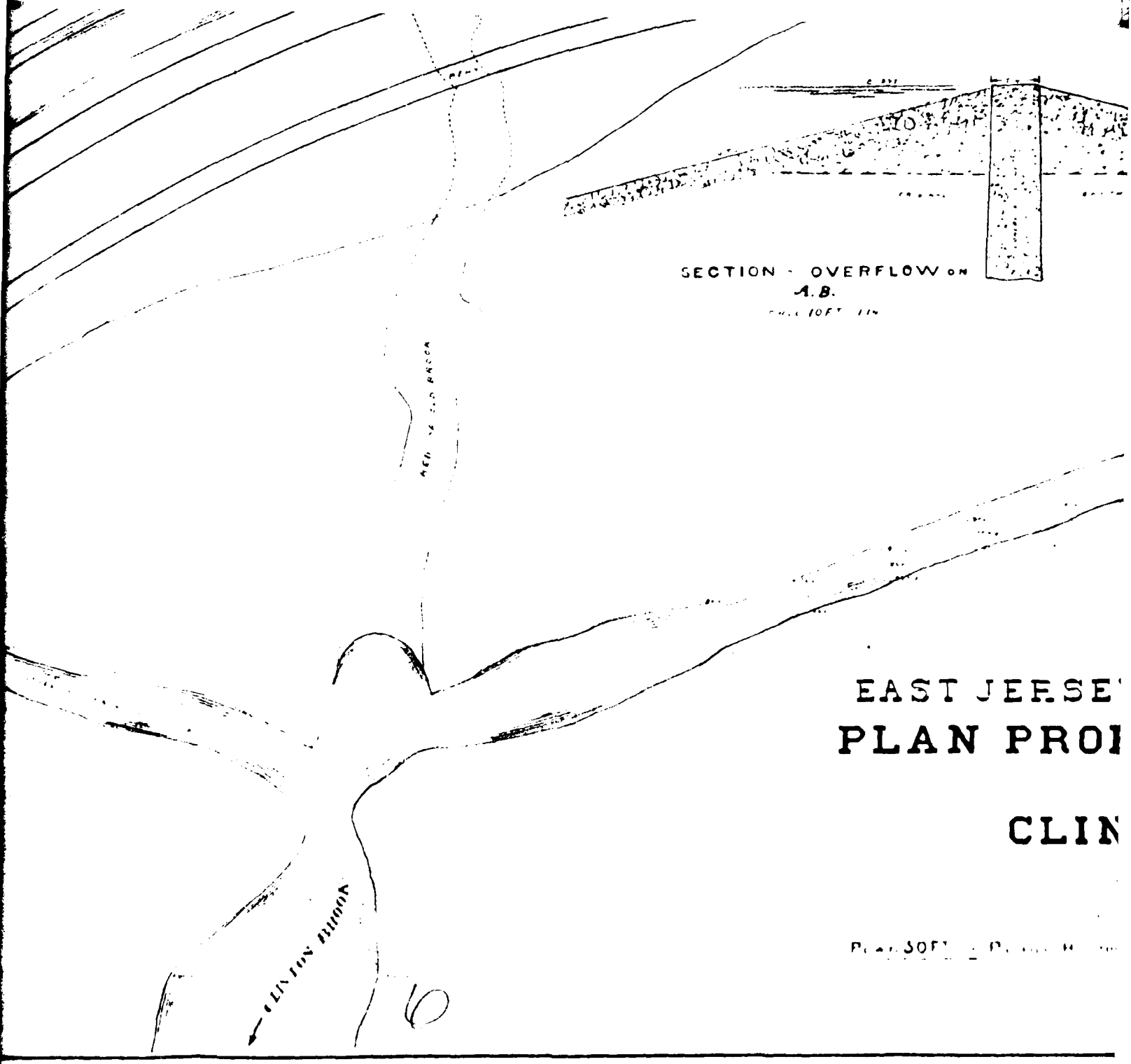


PROFILE SHEWING FOUNDATION OF CONCRETE CORE &c.




4
ROCK
FAN
HARD
&c.
B
A
WARWICK

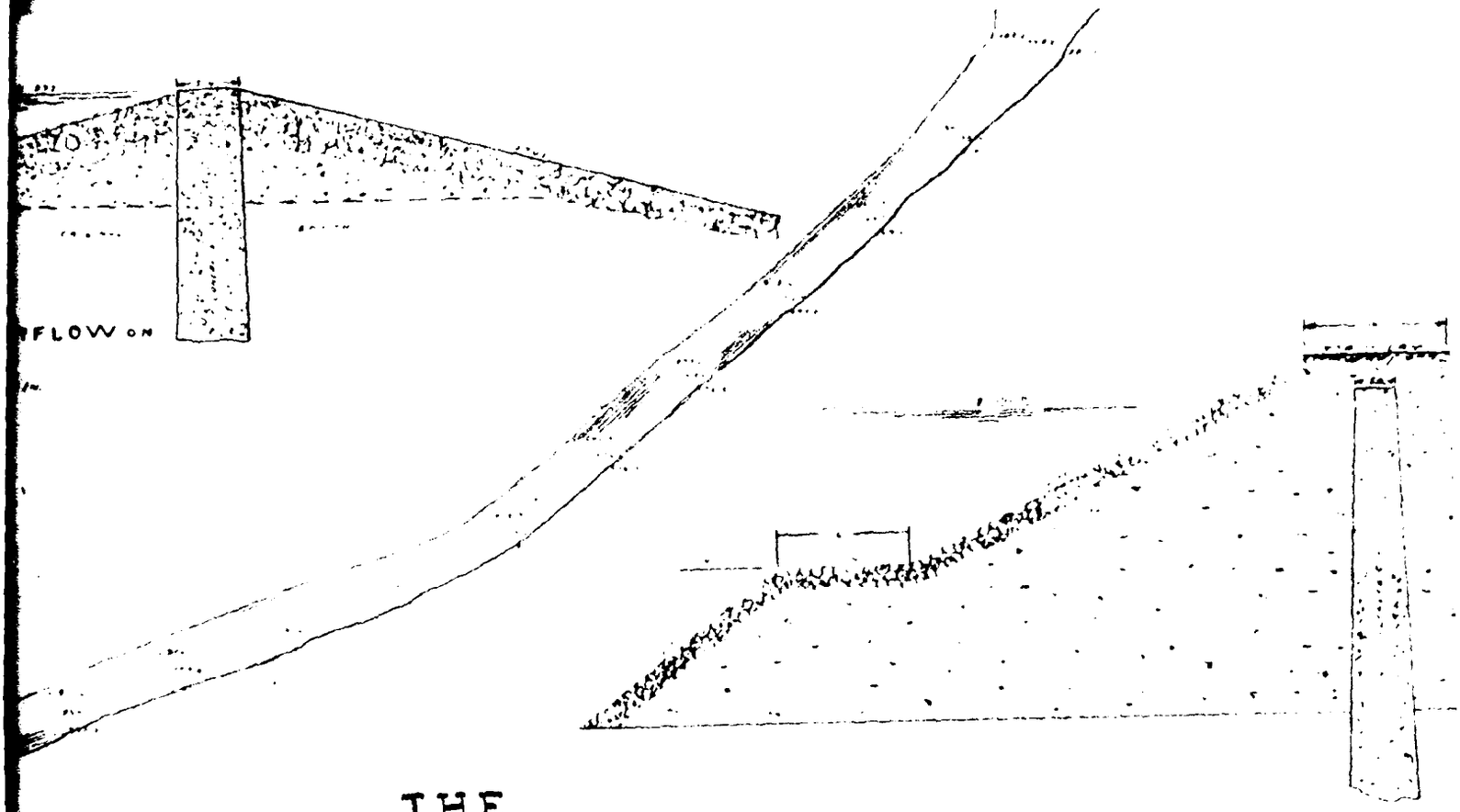




EAST JERSE

PLAN PROI

CLIN



THE

EAST JERSEY WATER COMPANY

PLAN PROFILE & SECTION

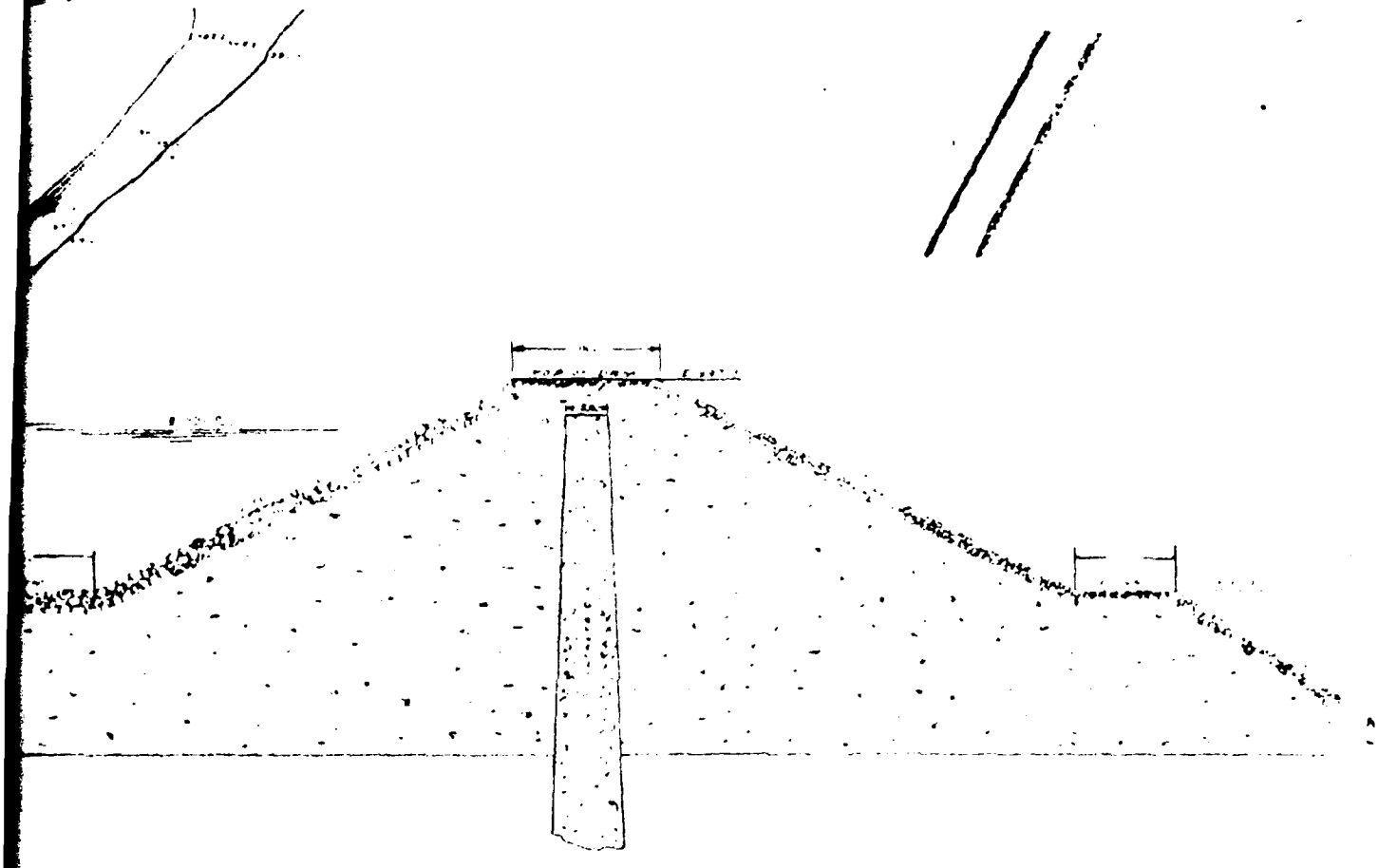
OF

CLINTON DAM

JUNE 1892

SCALES

SECTION D



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N

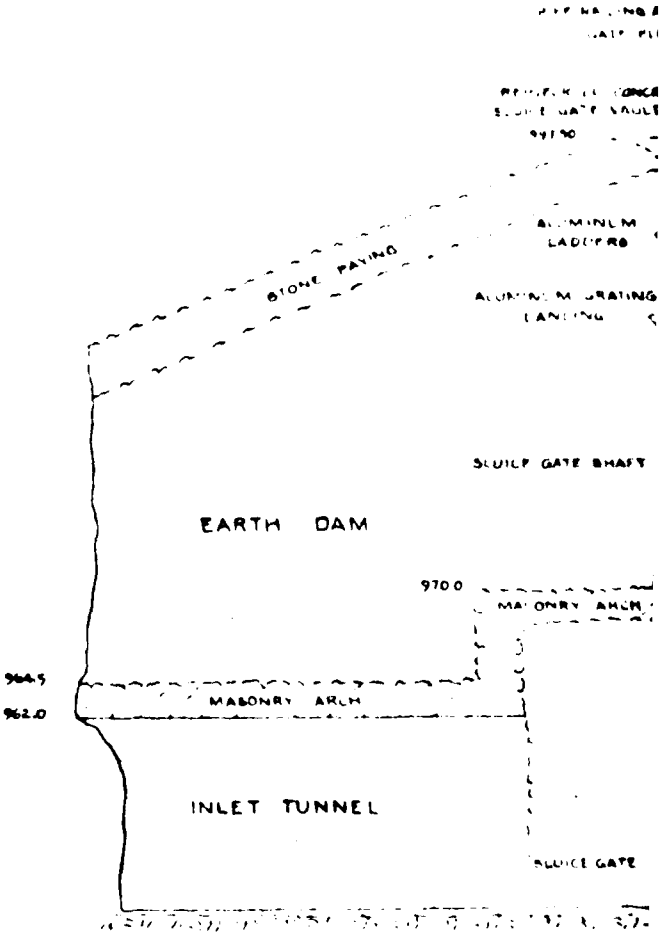
SECTION . DAM

PLATE 3

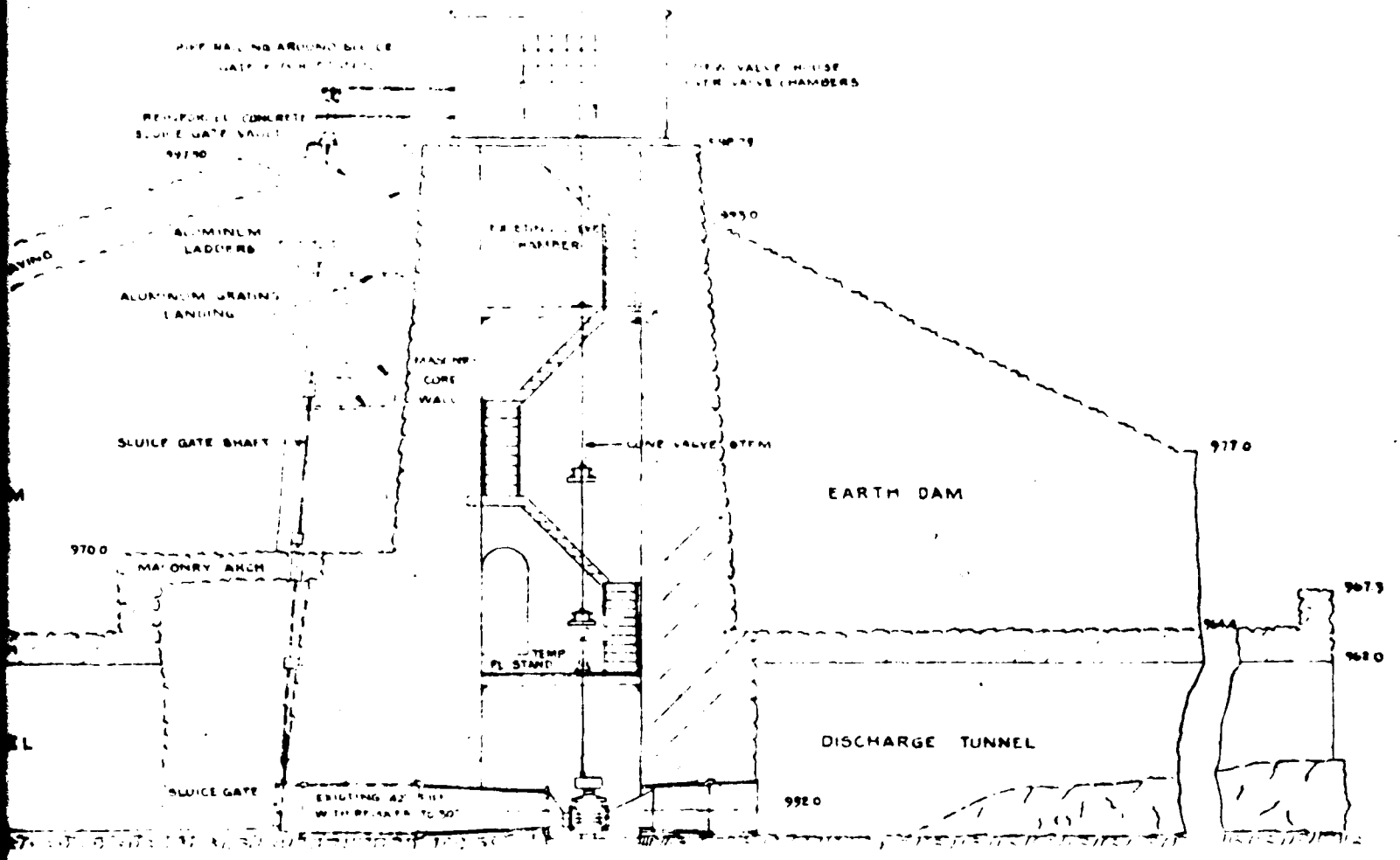
NOTE

SLUICE GATES AND VAULTS NOT

CLINTON RESERVOIR

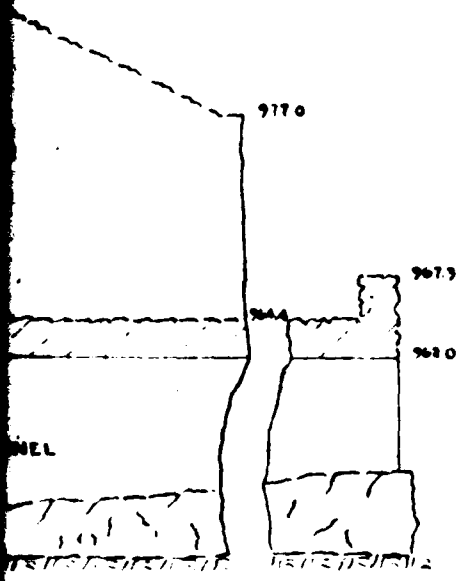


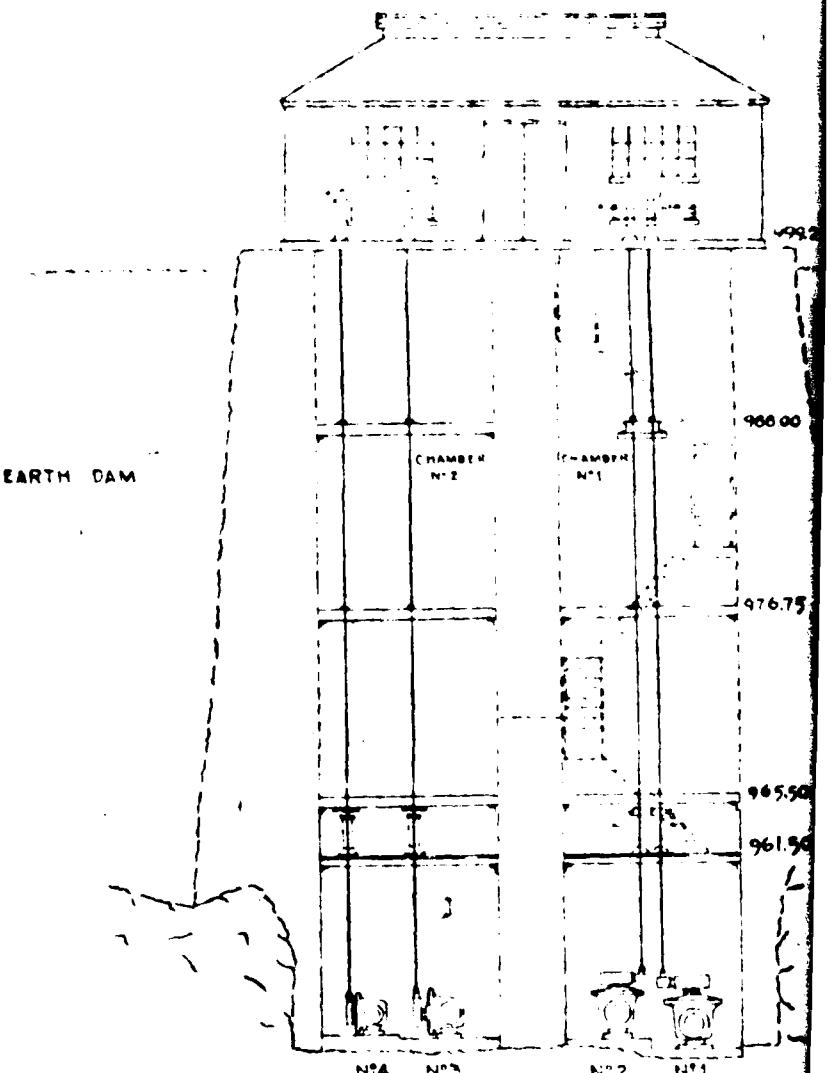
GATES AND VAULTS NOT IN THIS CONTRACT



SECTION A-A THROUGH SLUICE GATE VAULT AND VALVE CHAMBER

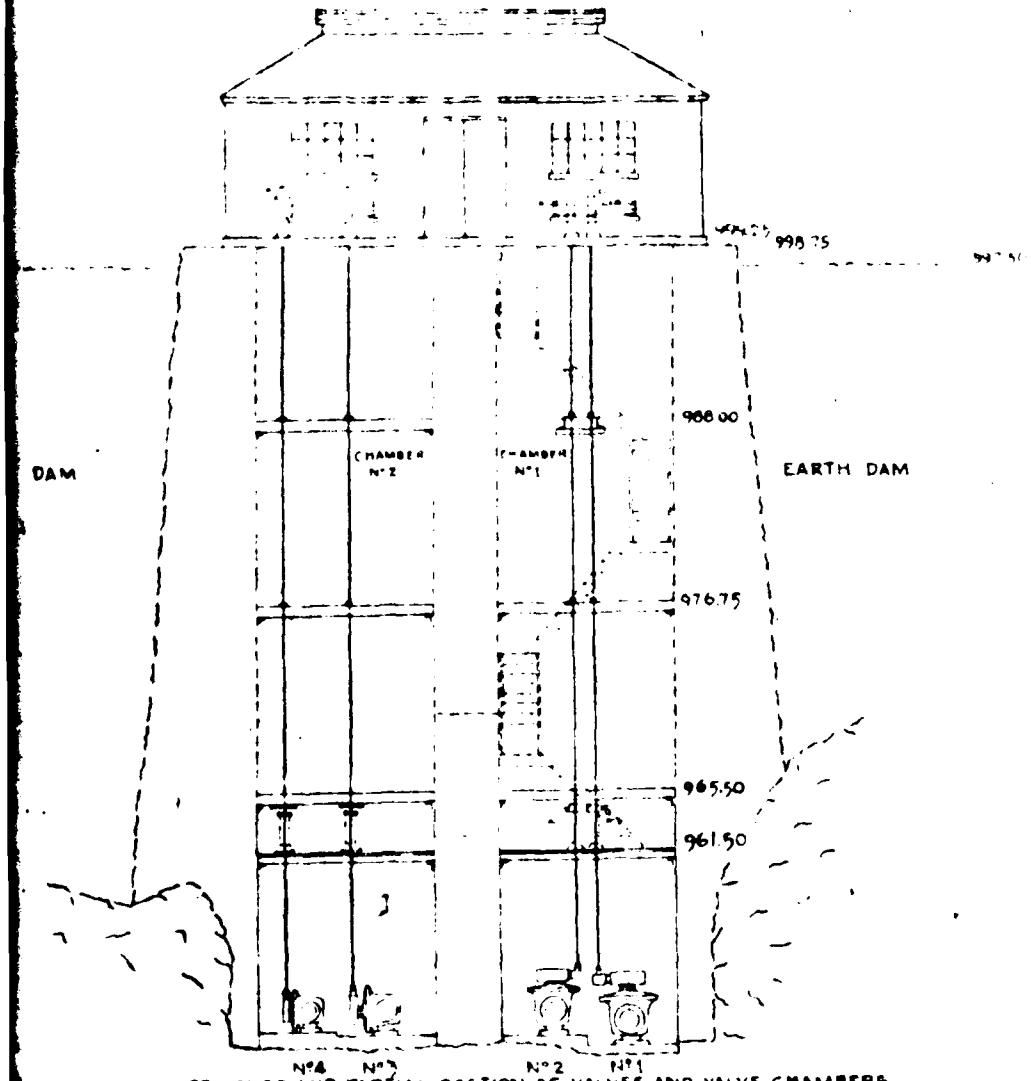
3



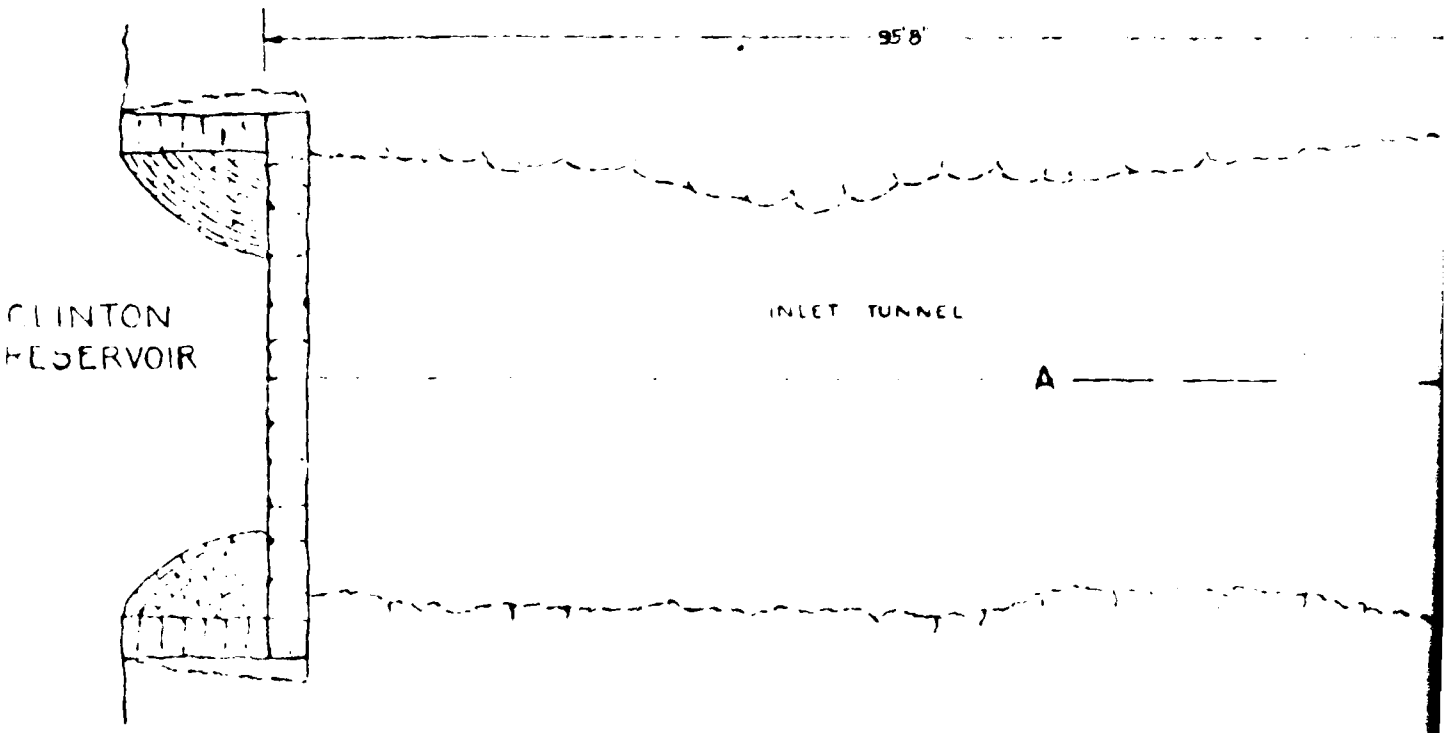


ELEVATION OF GATE HOUSE AND PARTIAL SECTION OF VALVES AND VALV
LOOKING SOUTH

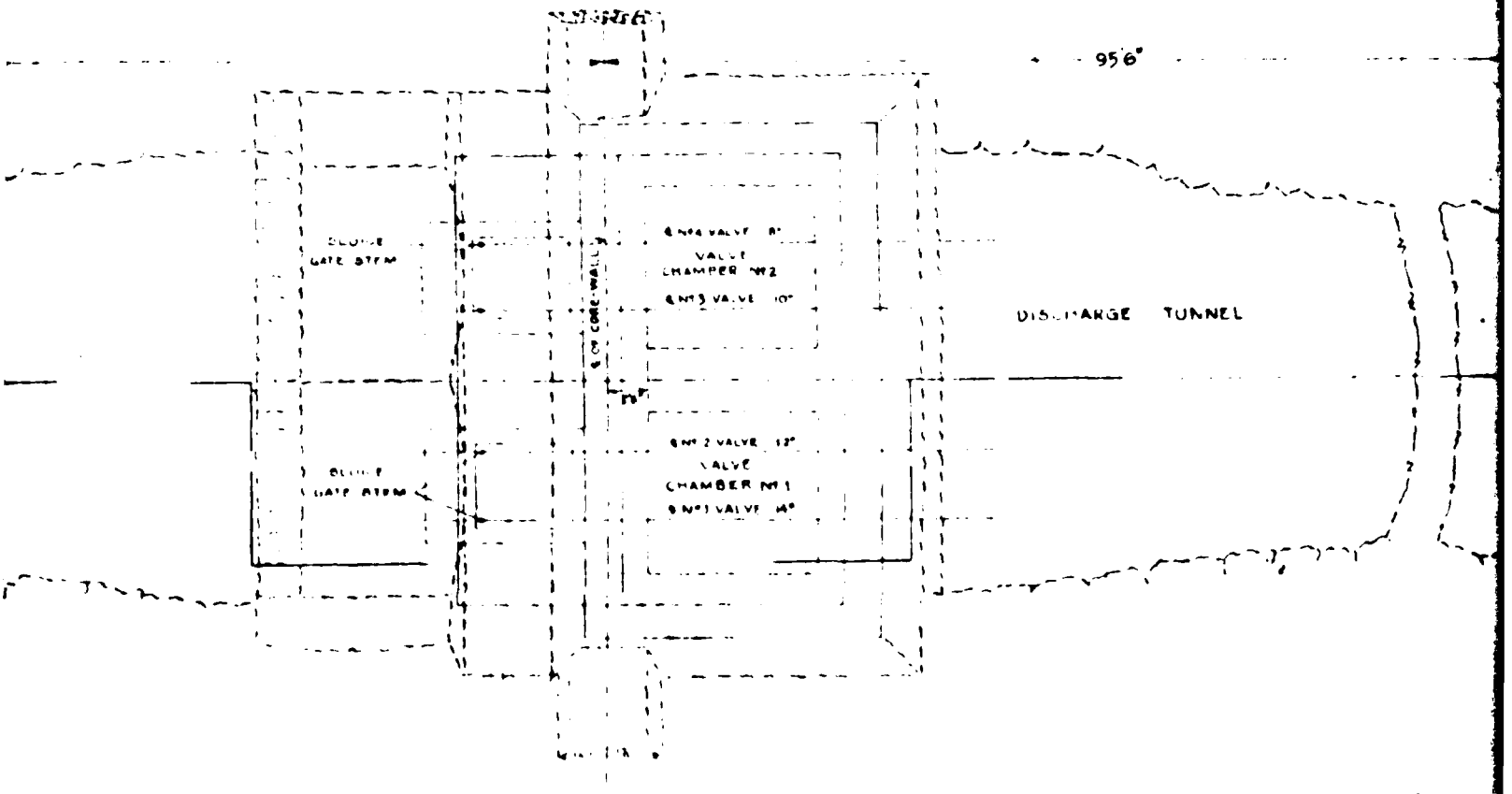
4



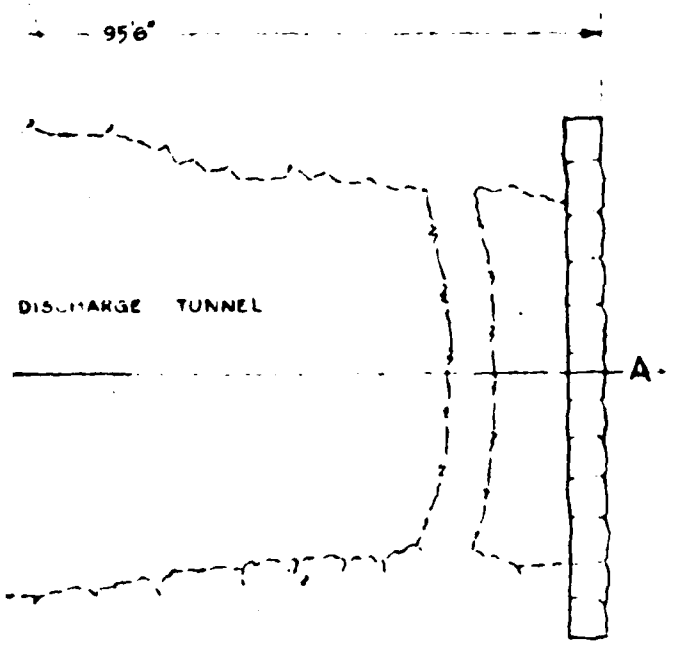
ELEVATION OF GATE HOUSE AND PARTIAL SECTION OF VALVES AND VALVE CHAMBERS
LOOKING SOUTH


95'8"
CLINTON
RESERVOIR
INLET TUNNEL
A

SECTION A-B

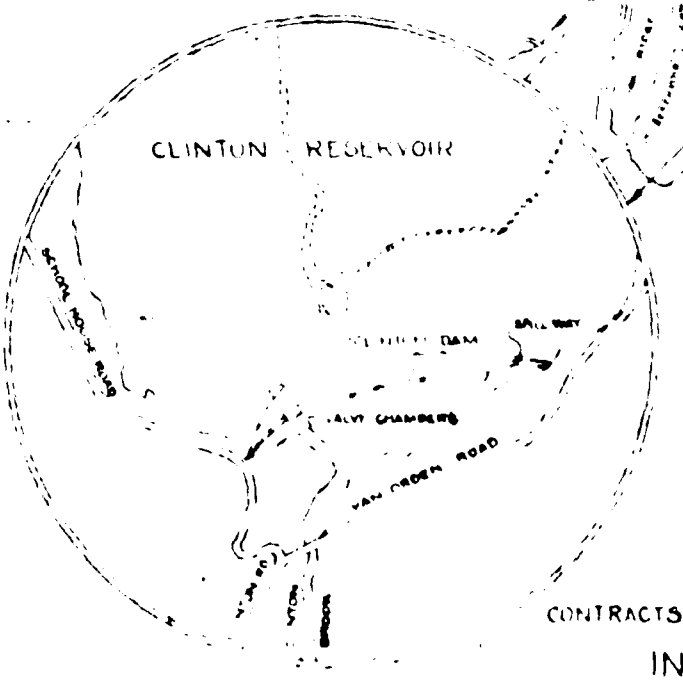


PLAN OF SLUICE GATE VAULTS, VALVE CHAMBERS AND TUNNELS



MAP OF WORK SITE

SCALE: 1 INCH = 1 MILE



DEPART
DIVIS

CONTRACTS NO 145 146A

INSTALLATIO

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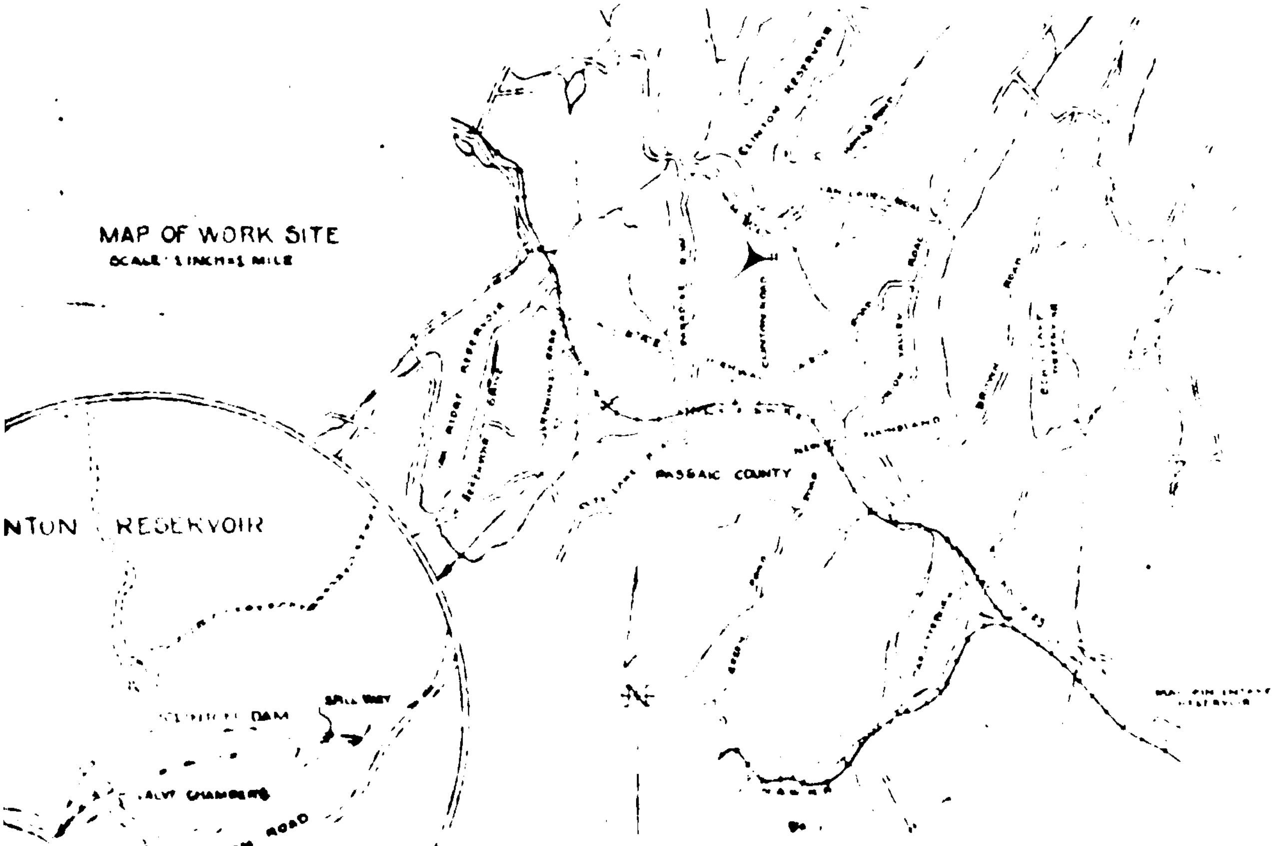
APPROVALS

RECEIVED
NOV 14 1979
HARRIS, HM.
WOODBRIDGE, N. J.



DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER SUPPLY
NEWARK, N.J.

CONTRACTS NO 146 - 146A

INSTALLATION OF 8", 10", 12" & 14" CONE VALVES
AND VALVE HOUSE

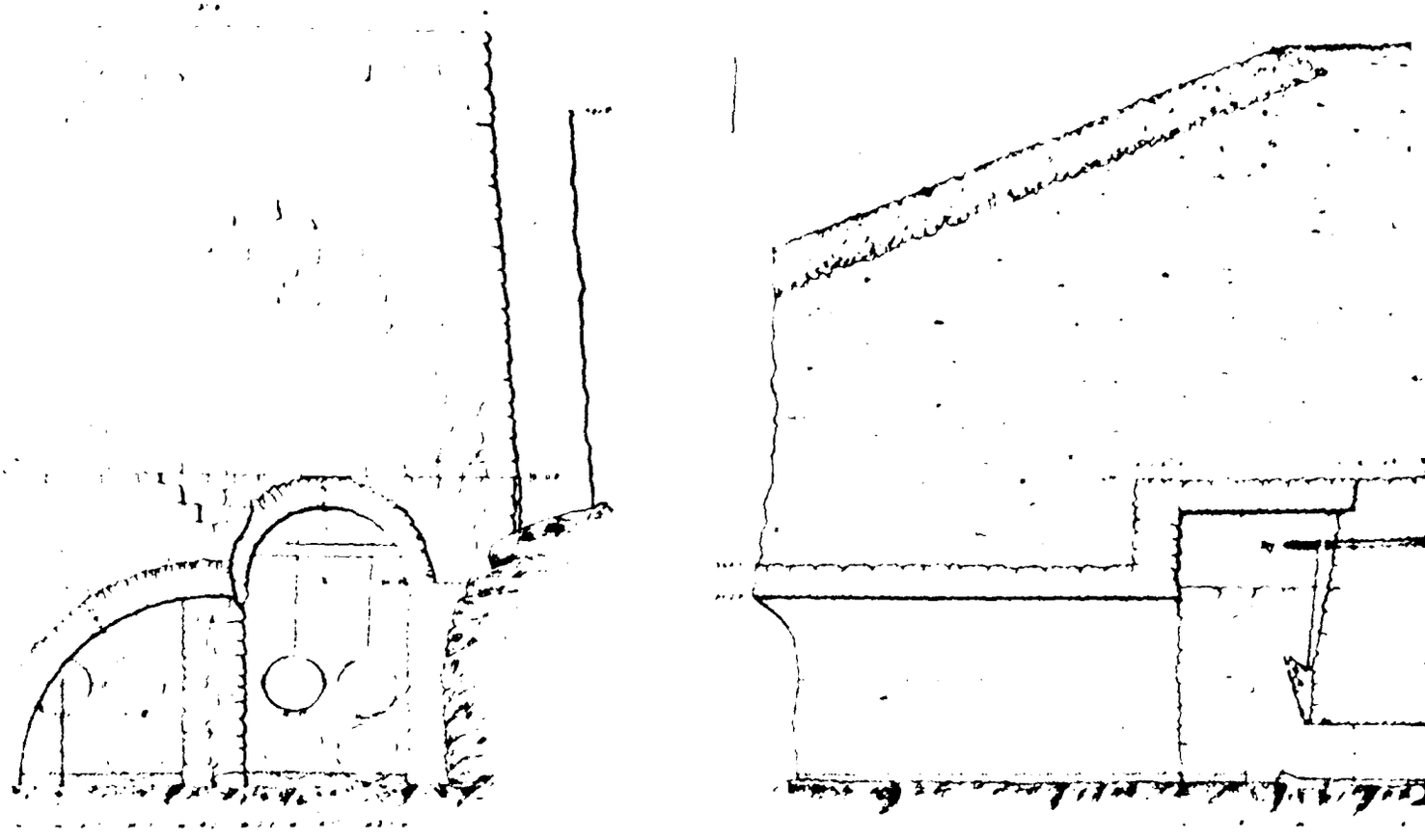
CLINTON RESERVOIR

APPROVALS

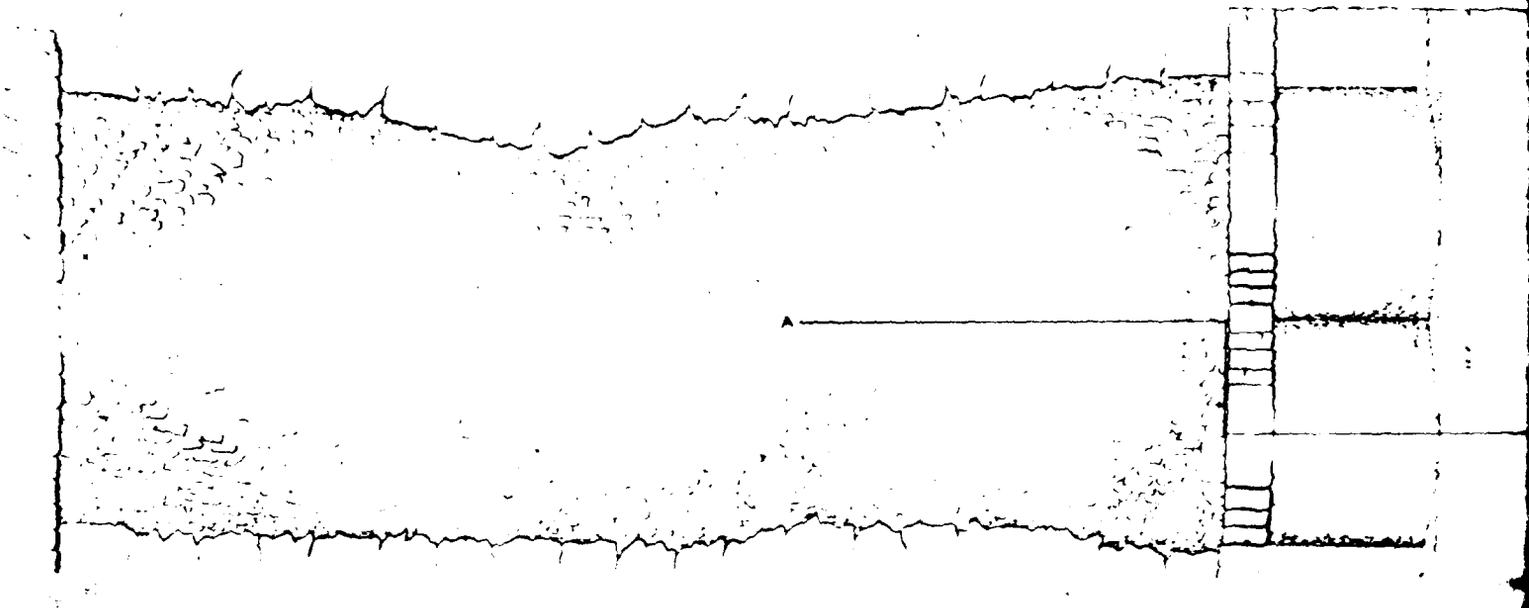
REVISED

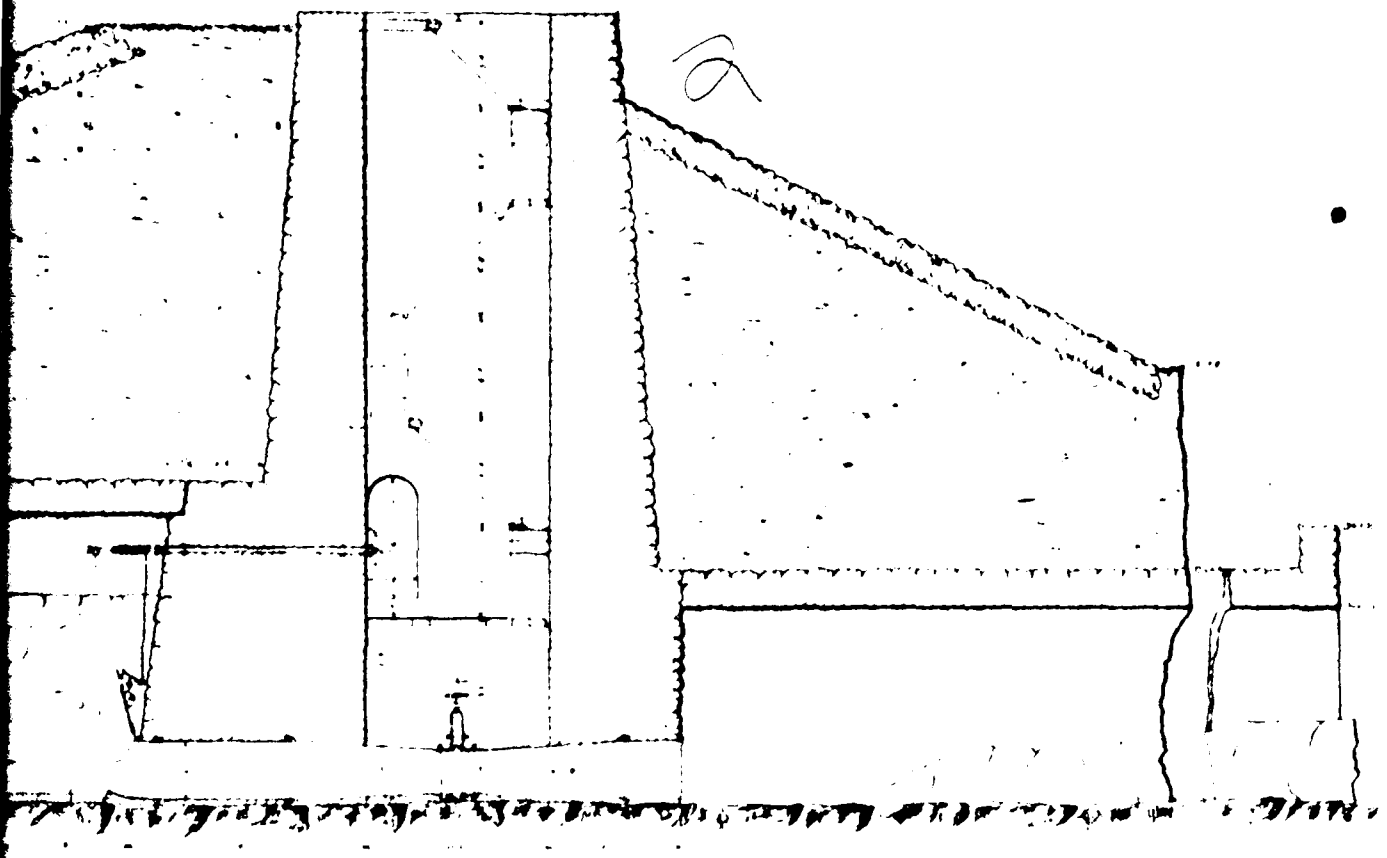
DATE

PLATE 5

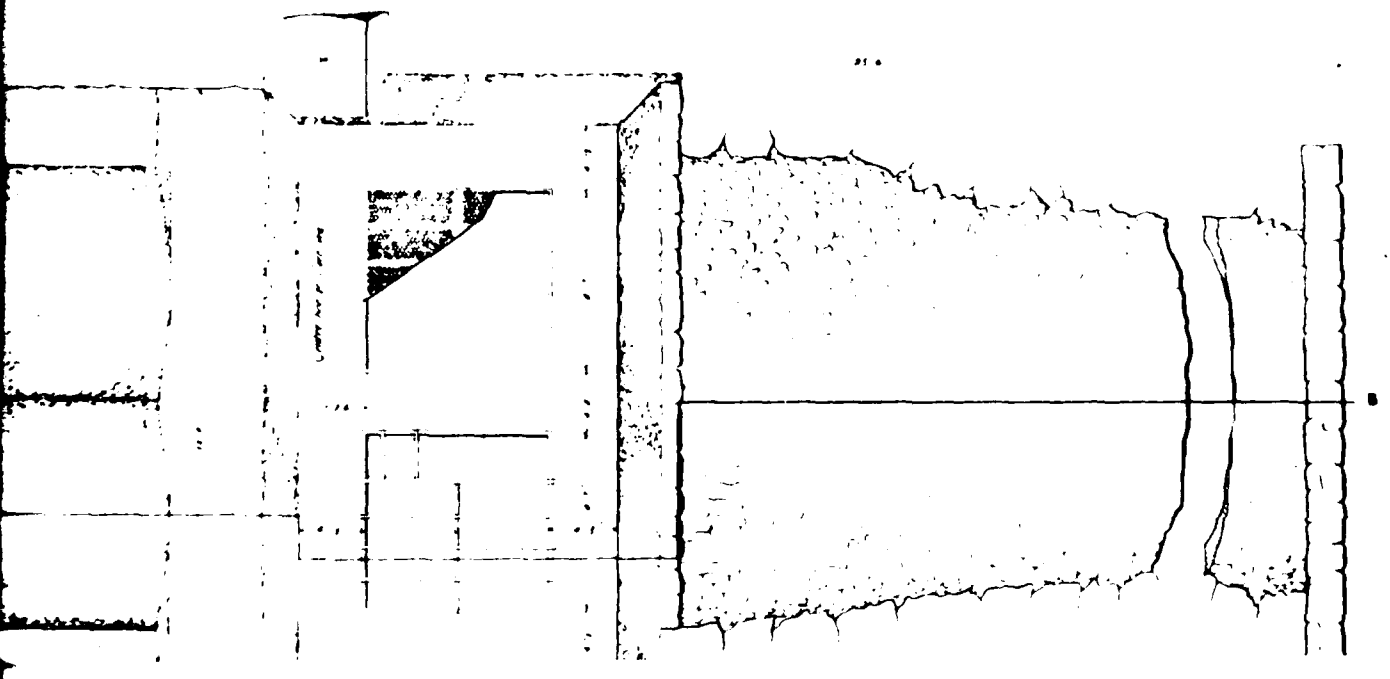


UP STREAM ELEVATION— UNCOVERED





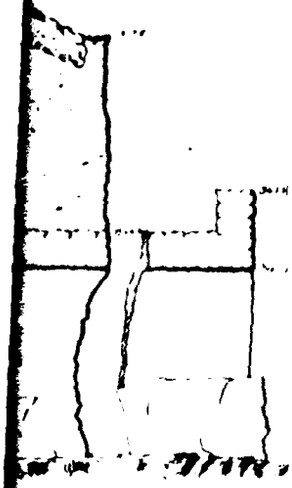
SECTION ON LINE AB



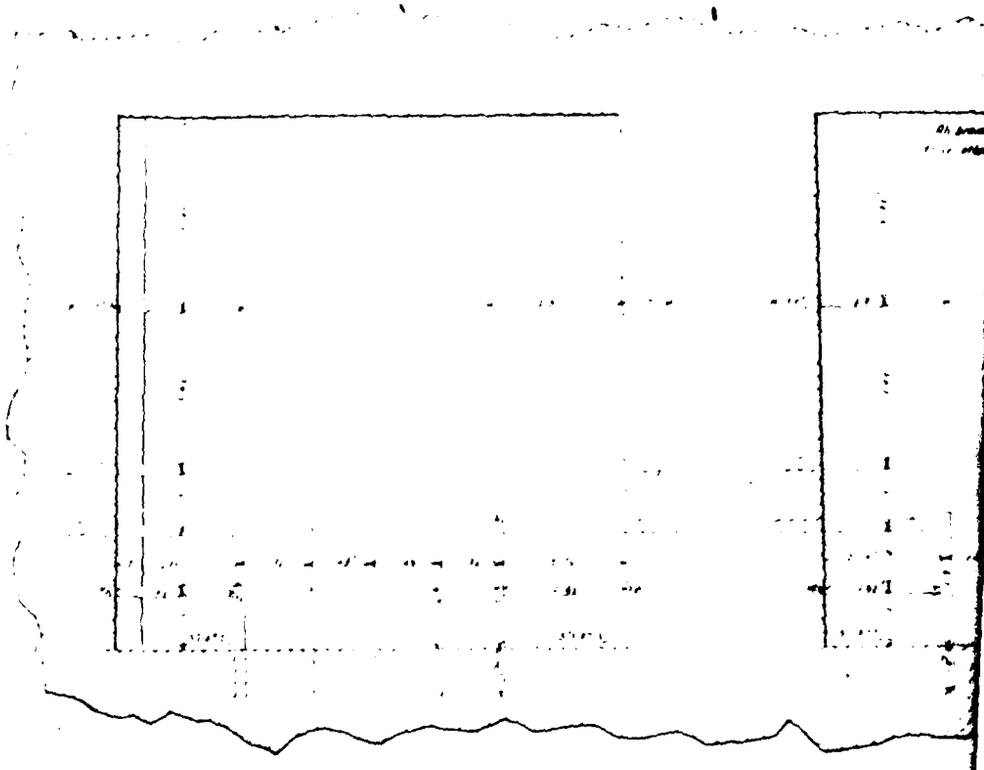
EAST JERSEY WATER COM

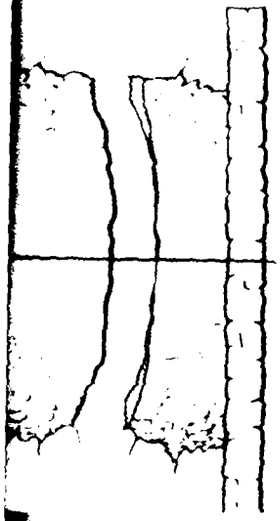
CLINTON GATE

MARCH 1892



PLATFORM BEAMS



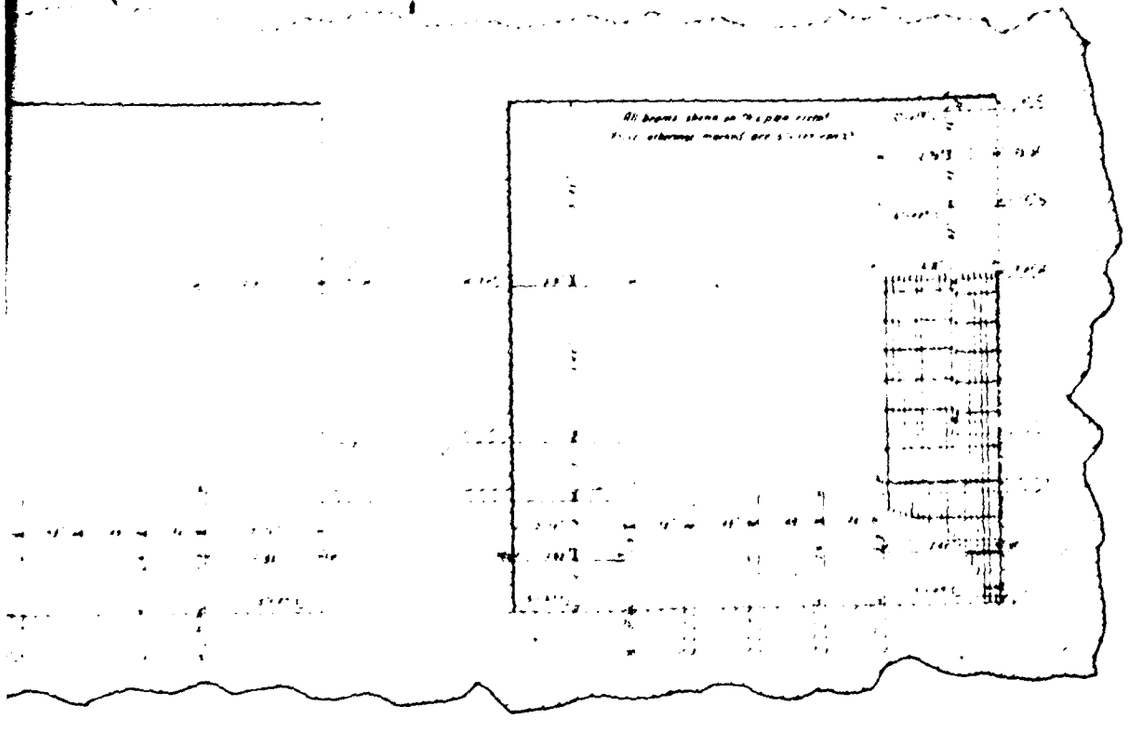


AST JERSEY WATER COMPANY

NTON GATE HOUSE

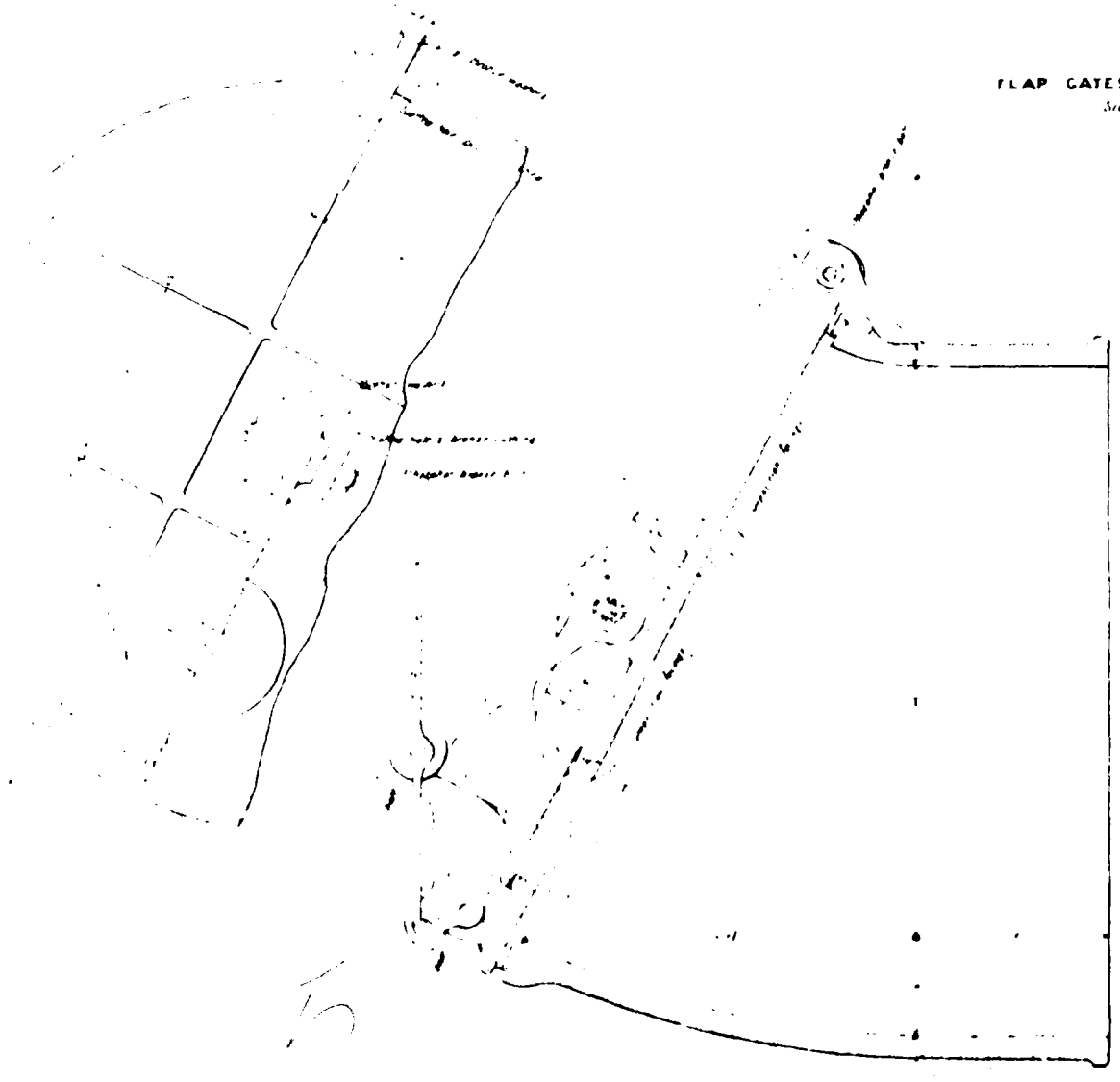
MARCH 1892

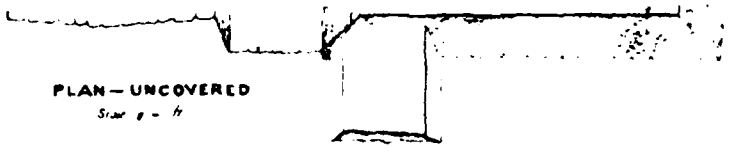
PLATFORM BEAMS



PLAN — UNCOVERE

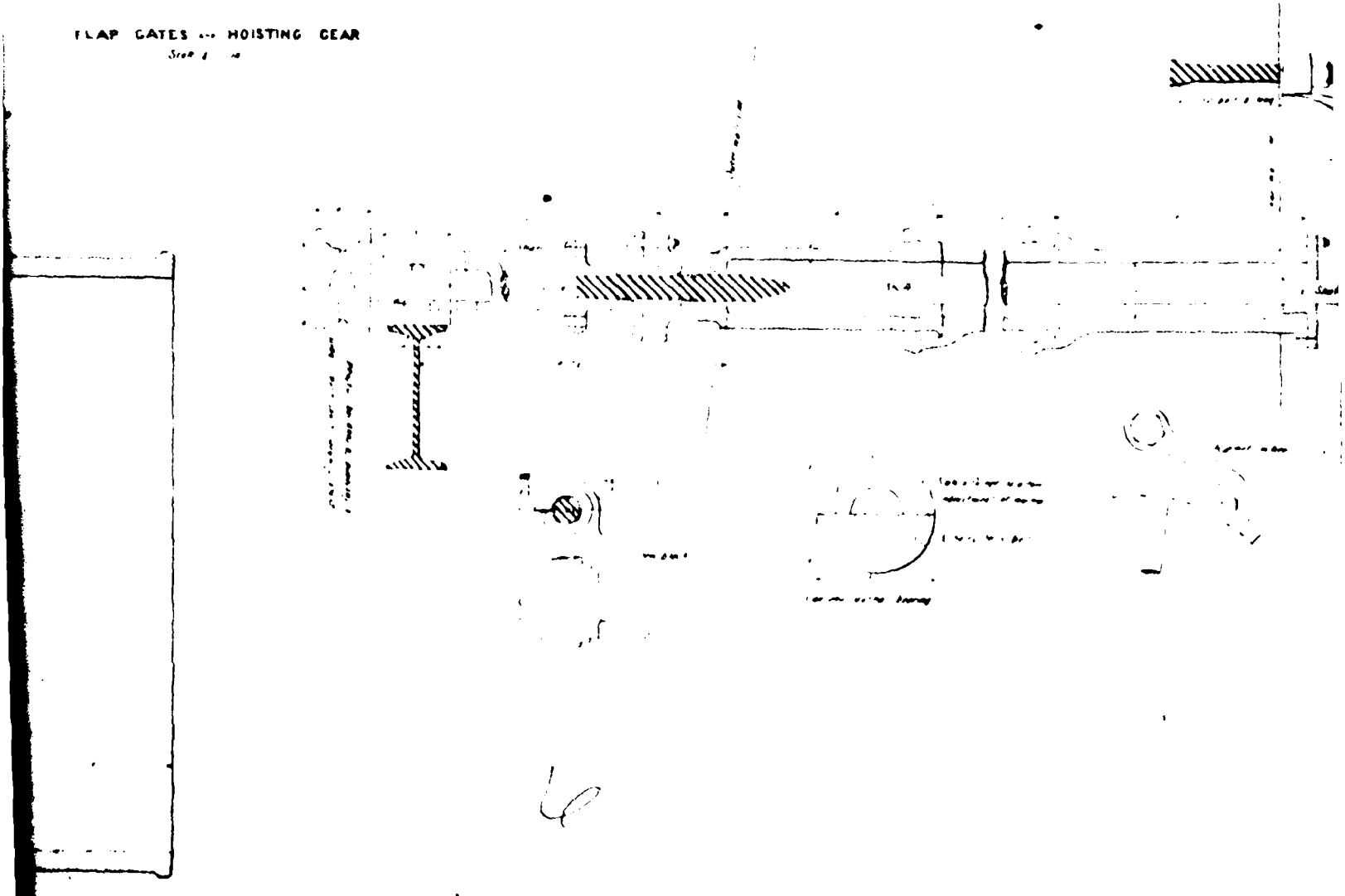
FLAP GATES — HOISTING GEAR

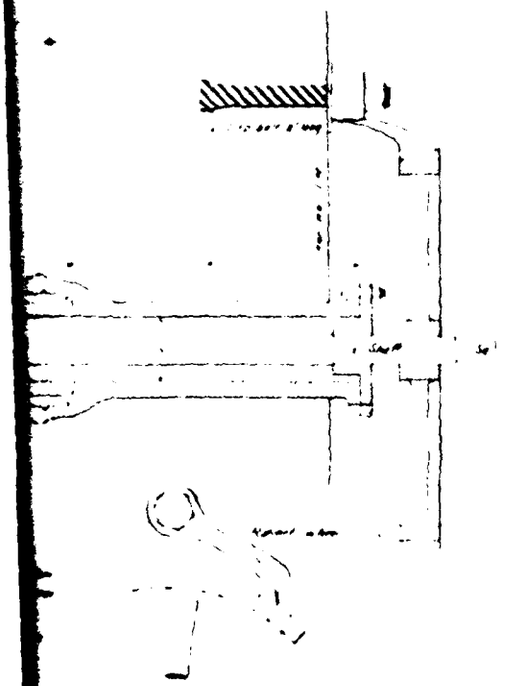


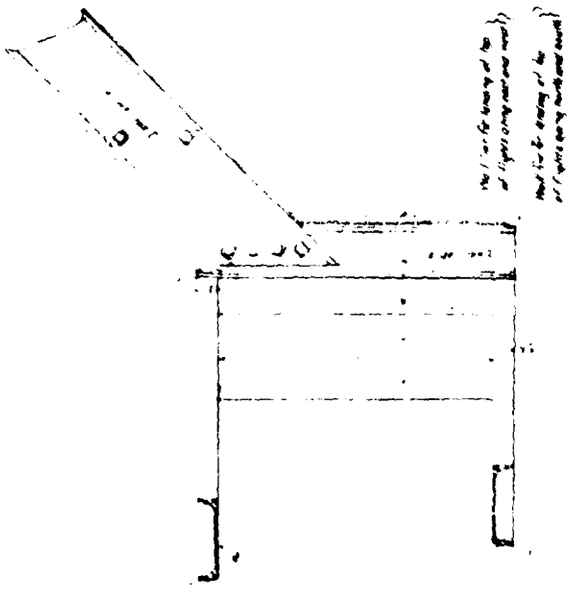


PLAN — UNCOVERED

FLAP GATES — HOISTING GEAR







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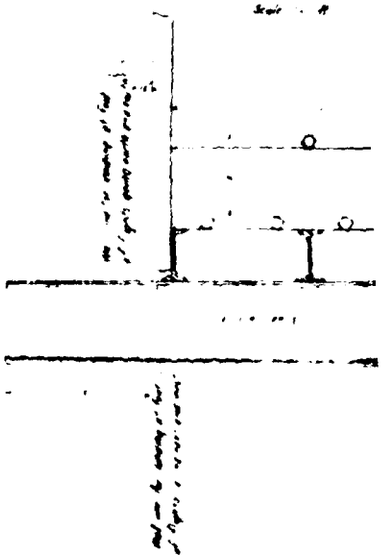
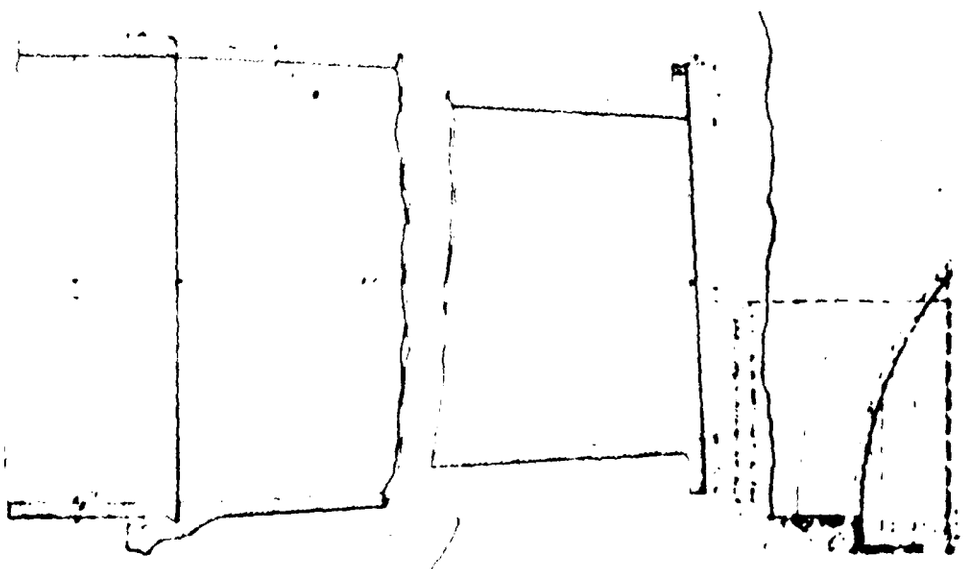
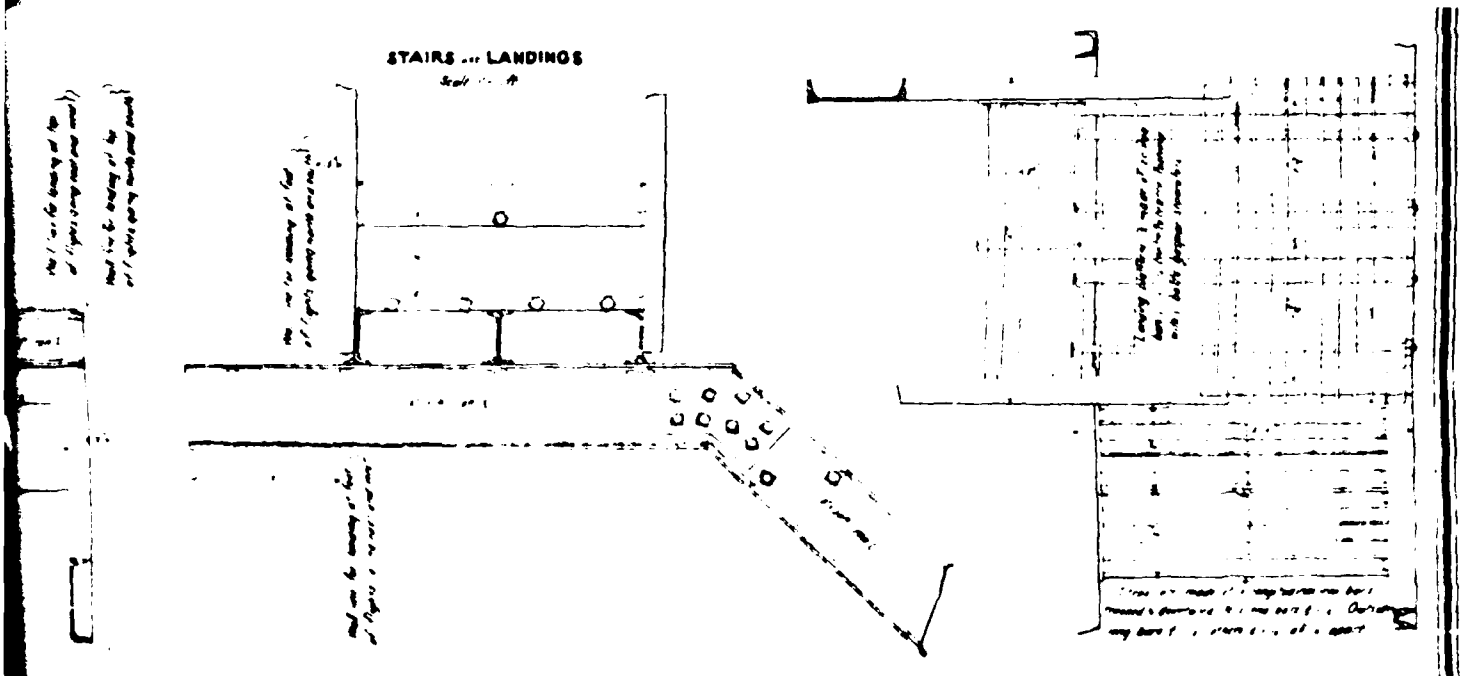


CONTRACTING PIPES



CASE 2 POC



PIPES

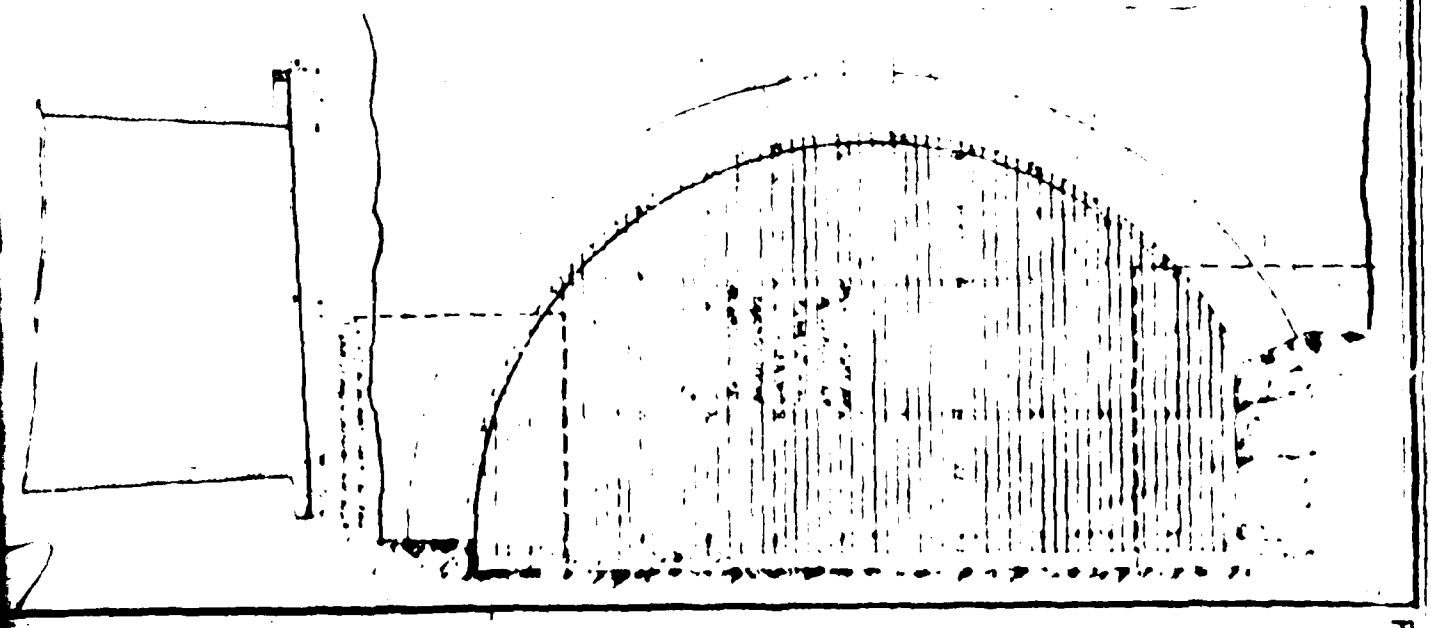


PLATE 4

APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam CLINTON RESERVOIR DAM County Passaic State New Jersey Coordinators NJ-DEP

Date(s) Inspection November 14, 1979 Weather Cloudy Temperature 48° F
December 4, 1979
December 15, 1979

Pool Elevation at Time of Inspection 990 NGVD Tailwater at Time of Inspection 945.5 NGVD

Inspection Personnel:

November 14, 1979

Chuck Chin
Eugene Koo (Recorder)
Thomas Lakovich

December 4, 1979

Chuck Chin
James McCormick

December 15, 1979

Walter Jones

OWNER/REPRESENTATIVE:

December 4, 1979

Glen Norman, Maintenance Foreman
City of Newark
Department of Public Works
Division of Water Supply
1294 McBride Avenue
Little Falls, N.J. 07424

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SEEPAGE OR LEAKAGE N/A		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS N/A		
DRAINS N/A		
WATER PASSAGES N/A		
FOUNDATIONS N/A		

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES N/A		
STRUCTURAL CRACKING N/A		
VERTICAL & HORIZONTAL ALIGNMENT N/A		
MONOLITH JOINTS N/A		
CONSTRUCTION JOINTS N/A		

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SURFACE CRACKS None noticed.		
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE None observed.		
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES None visible.		
VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST Good.		
RIPRAP FAILURES None		

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
EARTH EMBANKMENT:	Good condition. Has a few evergreen trees growing on its side slopes	Remove trees.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good.	
ANY NOTICEABLE SEEPAGE	Minor seepage, running clear, was noticed at the downstream toe of the embankment. The seepage is located at a point that is about 400 feet from the Valve House, toward the spillway. The seepage appears to be located at the "Bed of Old Brook" shown on Plate 3.	Monitor seepage for clearness and quantity.
STAFF GAGE AND RECORDER	None	
DRAINS	None.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN	Stilling basin is "tunneled" rock in good condition.	
INTAKE STRUCTURE	Underwater, not visible.	
OUTLET STRUCTURE	Four (4) 42-inch cast iron pipes, in good condition, underneath the Valve House discharge into a tunnel under the embankment.	
OUTLET FACILITIES	The tunnel under the embankment, receiving the discharge from the four pipes mentioned above, is cut through rock. The tunnel is arch-shaped. It is about 12 feet high and about 24 feet wide at its base. The flow through the pipes is controlled by cone valves.	
EMERGENCY GATE	None	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE WEIR	Fair conditon. A transverse crack exists across the concrete spillway. Vegetation is growing on downstream side of spillway.	Repair crack and remove vegetation.
APPROACH CHANNEL	Reservoir. Boulders missing in right abutment masonry wall. Also, the abutment wall needs re-grouting.	Repair walls.
DISCHARGE CHANNEL	Riprap, in good condition, at bottom of channel. Downstream side of spillway has leakage. Leakage is located about 60 feet downstream from the spillway crest, about 5 feet from the right abutment wall.	Monitor leakage for clearness and quantity.
BRIDGE AND PIERS	None	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONCRETE SILL N/A		
APPROACH CHANNEL N/A		
DISCHARGE CHANNEL N/A		
BRIDGE AND PIERS N/A		
GATES & OPERATION EQUIPMENT N/A		

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	Water level indicator. The type of level indicator was Weighted Steel Tape and Float. Operation of the level indicator was checked and found satisfactory.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
SLOPES	Moderate to steep side slopes. No indication of slope instability.	
SEDIMENTATION	None noticed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS AND RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Spillway channel is in good condition. The channel receiving flow from tunnel under embankment, at Valve House, is also in good condition. This channel is cut through rock and leakage was noticed on both banks of the channel near the tunnel.	Monitor leakage for clearness and quantity.
SLOPES	Spillway channel's side slopes are moderate. The channel that is cut through the rock, beyond the tunnel, has steep side slopes.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Both channels, mentioned above, meet approximately 1,000 feet from the spillway. The channel flows under Clinton Road, located about 1,300 feet from the spillway. One house is located on the channel's left bank approximately 1 mile from the spillway.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available at Manager's Office, City of Newark Department of Public Works, Division of Water Supply, 1294 McBride Ave., Little Falls, N.J. 07424
REGIONAL VICINITY MAP	Available-Passaic County Map and U.S.G.S. Quadrangle Sheet for Newfoundland, N.J.
CONSTRUCTION HISTORY	No formal history exists, but it can be deduced from available plans and drawings.
TYPICAL SECTIONS OF DAM	Available at Manager's Office (listed above)
HYDROLOGIC/HYDRAULIC DATA	None available.
OUTLETS - PLAN	Available at Manager's Office (listed above)
- DETAILS	Available at Manager's Office (listed above)
- CONSTRAINTS	None
- DISCHARGE RATINGS	Not available.
RAINFALL- RESERVOIR RECORDS	Available at Manager's Office (listed above)

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
DESIGN REPORTS	None available.
GEOLOGY REPORTS	Available U.S.G.S. Geologic Overlay Sheet for Passaic County and Engineering Soil Survey of New Jersey, Report No. 3--Passaic County by Rutgers University (New Brunswick, N.J.).
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.
POST-CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	Unknown.
SPILLWAY PLAN - SECTIONS - DETAILS	Available at Manager's Office (listed above)

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

ITEM	REMARKS
OPERATING EQUIPMENT PLANS AND DETAILS	Available at Manager's Office (listed above)
MONITORING SYSTEMS	Water level indicator plans not available.
MODIFICATIONS	Valve House, constructed on top of embankment in 1980, drawings are available at Manager's Office listed above.
HIGH POOL RECORDS	Daily records have been kept since 1972.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None known to exist.
PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION - REPORTS	None known to exist.
MAINTENANCE OPERATION RECORDS	Kept since 1971.

APPENDIX B

PHOTOGRAPHS

(Taken on November 14 and December 4, 1979)

Photo 1 - View of downstream side of the embankment looking toward the spillway at the left end of the dam. Valve House and portion of reservoir are visible at upper left of photo. (Photo taken on November 14, 1979).

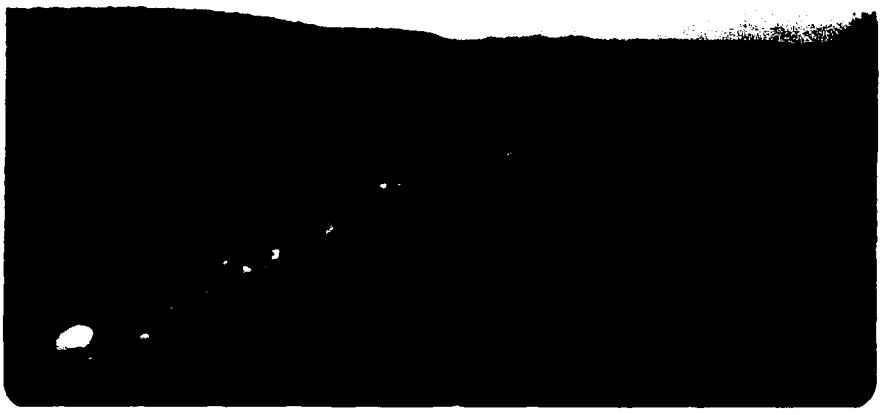


Photo 2 - View of embankment looking toward the spillway at the left end of the dam. Riprap is visible on the upstream side of the embankment. (Photo taken on November 14, 1979).

Photo 3 - View of reservoir from downstream, right side of dam. Valve House is at center right of photo. (Photo taken on November 14, 1979).

Photo 4 - View of embankment looking toward Valve House and right side of dam. The low level outlet channel, from Valve House, is visible at left center of photo. (Photo taken on November 14, 1979).

Photo 5 - View from Valve House looking downstream toward the low level outlet's channel. (Photo taken on November 14, 1979).

Photo 6 - View from the low level outlet channel looking upstream toward the tunnel under the embankment and the Valve House. Note channel cut out of rock. (Photo taken on November 14, 1979).

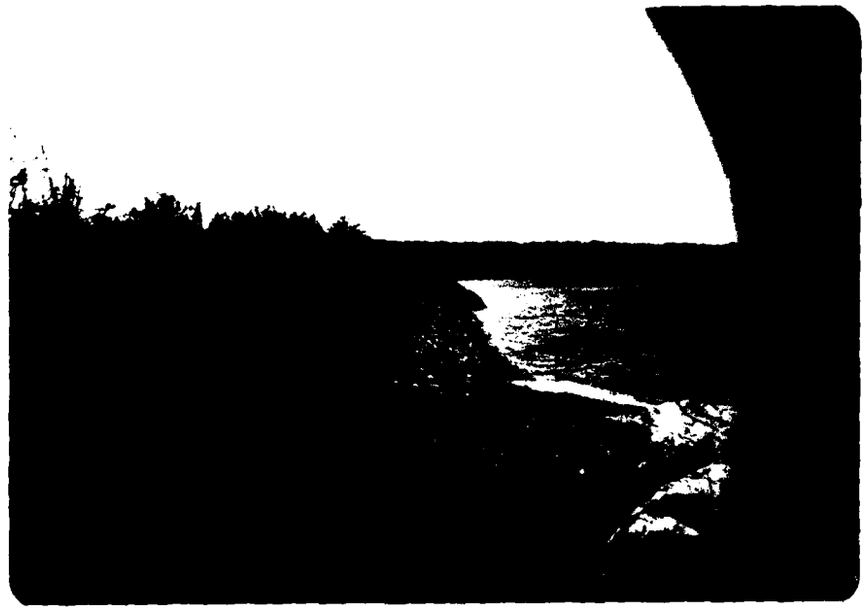


Photo 7 - View from the spillway's left abutment, in foreground, toward the embankment and right end of dam. (Photo taken on November 14, 1979).

Photo 8 - Detail of the spillway's right abutment wall. Note missing boulders and missing grout in the wall. (Photo taken on November 14, 1979).

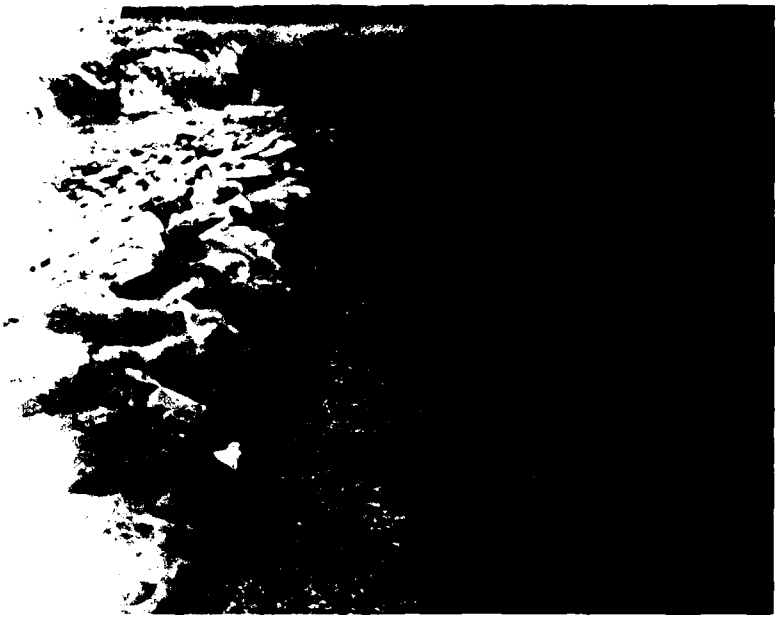


Photo 9 - Detail of spillway looking toward the left abutment wall. Note crack in spillway. (Photo taken on November 14, 1979).

Photo 10 - View from the spillway looking toward the downstream channel. Photo taken on December 4, 1979).

APPENDIX C

SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: CLINTON RESERVOIR DAM

Drainage Area Characteristics: 9.10 square miles

Elevation Top Normal Pool (Storage Capacity): 992 NGVD (10,796 acre-feet)

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: 999.26 NGVD (SDF pool: 14,272 acre-feet)

Elevation Top Dam: 997.5 NGVD (13,372 acre-feet)

SPILLWAY CREST:

a. Elevation 992 NGVD

b. Type Broad crest weir

c. Width 300 ft.

d. Length 5.4 feet

e. Location Spillover Unknown. Water level was below spillway crest.

f. No. and Type of Gates None

OUTLET WORKS:

a. Type 4 - 42 inch C.I.P. pipes with 8,10,12, & 14 inch cone valves.

b. Location Right side of dam under valve (gate)house.

c. Entrance Inverts 950.3 NGVD

d. Exit Inverts 950 NGVD

e. Emergency Draindown Facilities 4 cone valves 8,10,12, & 14 inch dia.

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

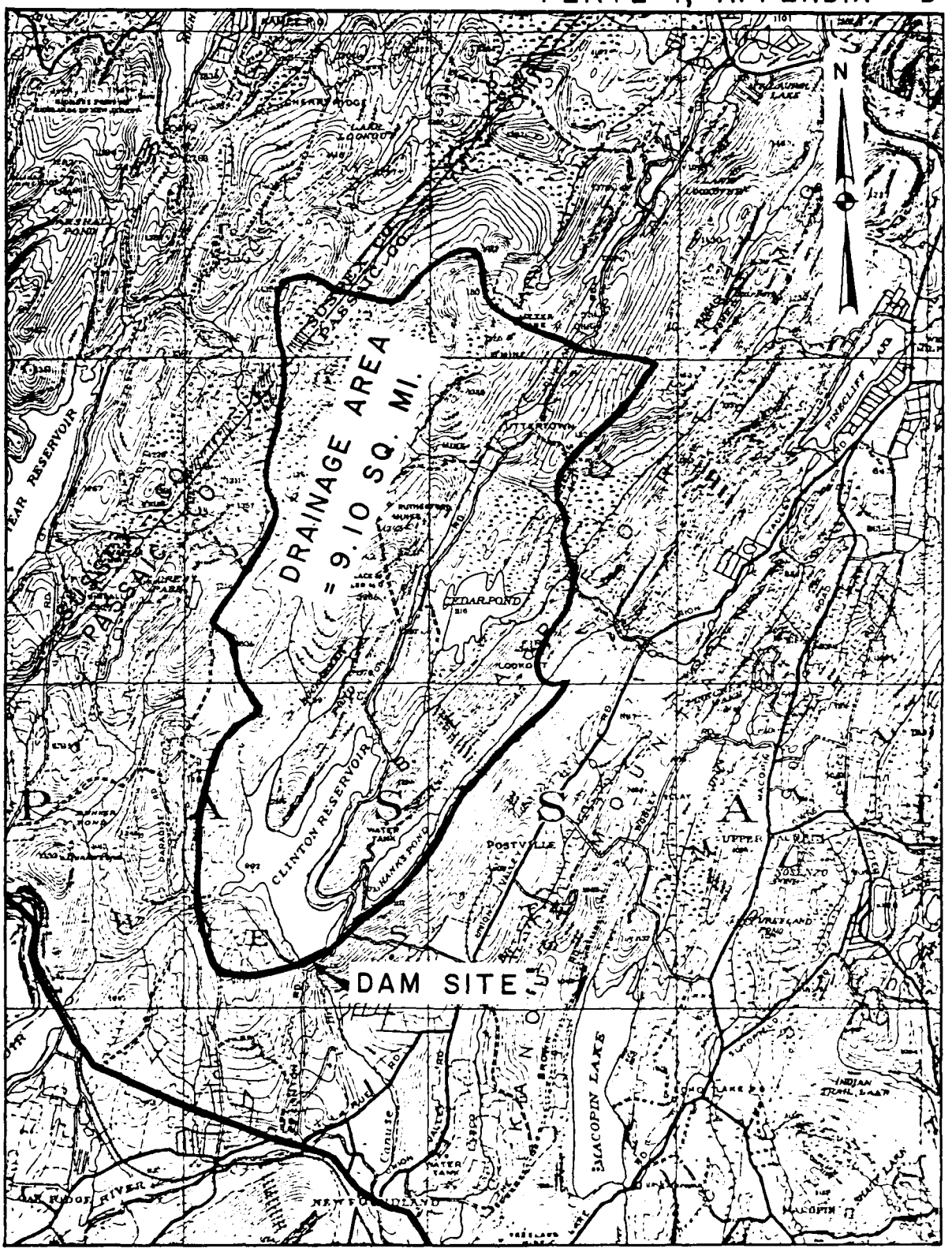
c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: 10,448 cfs at elevation 997.5 NGVD.

APPENDIX D

HYDROLOGIC COMPUTATIONS

PLATE 1, APPENDIX D



CLINTON RESERVOIR DAM
DRAINAGE BASIN

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT NJ DAM SAFETY INSPECTION
CLINTON RES.
COMPUTED BY CLC CHECKED BY

SHEET NO. 1 OF 9
JOB NO. 10-AB3-01
DATE 3/3/80

GROUP XVII

SIZE CLASSIFICATION

Surface Area of Main Impoundment	405 Acres
Ave. Depth of Reservoir	40 ft
Structural Height of Dam	55.5 ft
Size Classificaton	Intermediate

HAZARD POTENTIAL CLASSIFICATION

Three Houses & 3 Heavily Travelling Roads
Approximately One Mile D/S of Dam

Hazard Potential Classificaton	HIGH
Recommended SDF	PMF

HYDROLOGIC ANALYSIS

The HEC-1 DB will be used to route the flood using SCS Triangular Unit Hydrograph with Curvilinear Transformation

D.A. = 0.10 mi^2

PRECIPITATION

From fig. 15 (Ref.: 'Design of Small Dam,' p. 48), the drainage basin located at the boundary between Zone 1 & Zone 6 where the Probable Max. Precipitation = 25 inches based on 6 HRs. duration & a 10 SQ. MI. basin area.

DURATION (HRS.)	% of PMF			
	ZONE 1	ZONE 6	AVG.	
6	99	100	100	Note: Values are reduced by 20% to account for misalignment of basin & storm isohytals.
12	111	109	110	
24	119	117	118	
48	127	126	127	

INFILTRATION DATA

Drainage Area Consists of Most of Sc, Mmg & Z. (Reference "Engineering Soil survey of N.J. - Passaic County, by Rutgers University)

Hydrologic soil	%
Initial Infiltration	0.8 INCH
Const. Minimum Rate	0.08 IN/HR.

TIME OF CONCENTRATION

1) Estimating T_c from Velocity Estimating & Water Course Length :

	Slope	Vel.	Remarks
Overland Flow	$\frac{1420-1250}{520} = 0.33$	4.0	Woodlands
Channel Flow	$\frac{1250-1000}{17000} = 0.014$	1.5	

$$t_c = \left(\frac{520}{4} + \frac{17000}{1.5} \right) \Big/ 3600 = 3.18 \text{ HRS.}$$

2) FROM NOMOGRAPH "Design of Small Dam"

$\Delta H = 1420 - 980 = 440'$ $L = 18480'$

$T_c = 1.0$ HR.

3) USING F.A.A. FORMULA FROM SURFACE FLOW

$$T_c = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt[3]{S}}$$

$D = 18480'$

$C = 0.15$ WOODED AREA

$S = \frac{440}{18480} = 2.38\%$

$\therefore T_c = 2.9$ HRS.

TIME OF CONCENTRATION (CONTINUED)

4) G. B. WILLIAMS FLOOD COMMITTEE

$$t = 0.908 \; L \sqrt[5]{\frac{1}{FD}}$$

Where t ~ time period in hrs.
L ~ length of catchment in miles
D ~ Diameter in miles of a circle having the same area
F ~ catchment slope in %

$$t = 0.908 \; (5.3) \sqrt[5]{\frac{1}{(2.38)(3.56)}} = 3.14 \text{ HRS.}$$

Use $T_c = 2.56$ HRS.

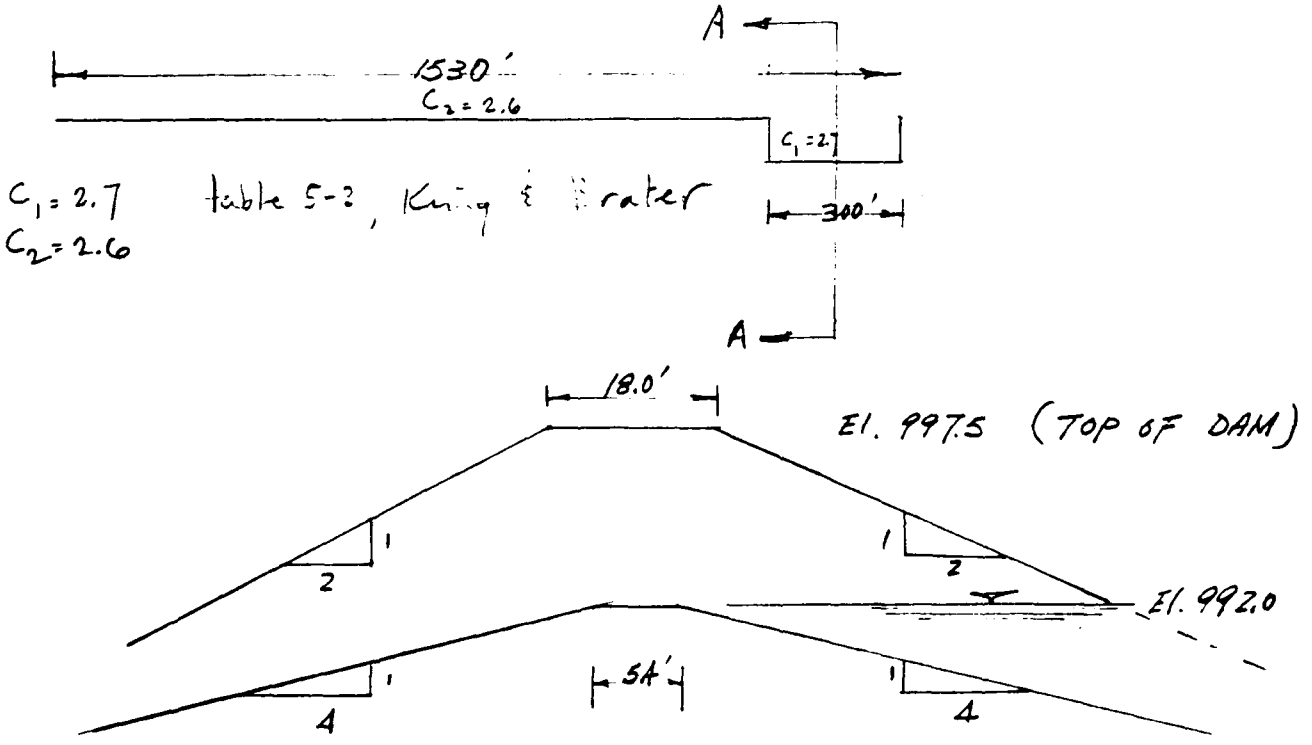
$LAG = 0.6 \; T_c = 1.53$ HRS.

ELEVATION - AREA - CAPACITY RELATIONSHIP

Reservoir Storage values were obtained from Water Supply Division City of Newark

Elev.	950	951	960	965	970	975	980	985	990	991	992	993	994	1000
Storage Ac-Ft	0	25	1271	2246	3400	4744	6316	8009	10011	10404	10796	11189	11587	14647*

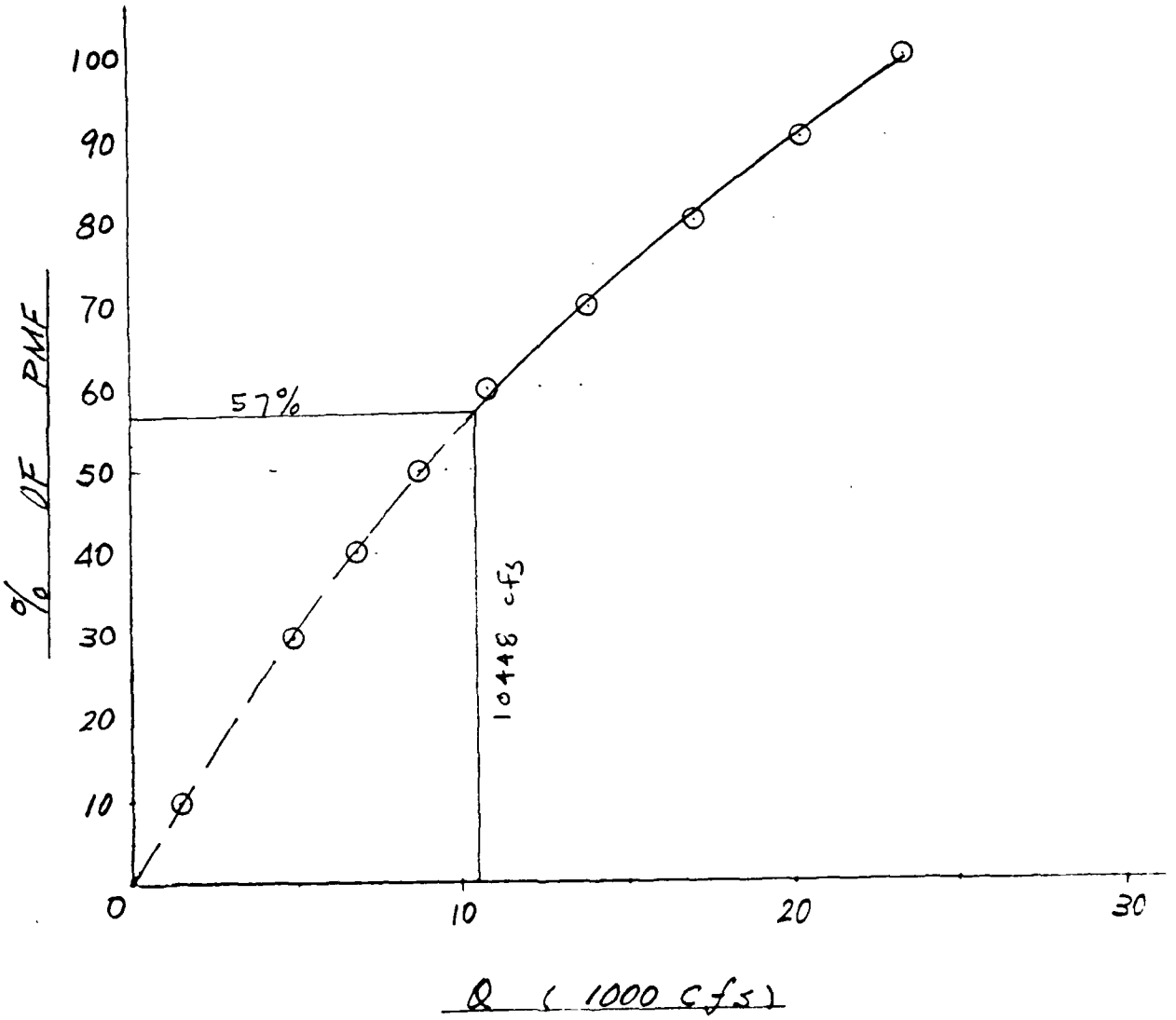
* The value of Storage at Elev. 1000 was developed thru HEC-1 DB program



$C_1 = 2.7$ table 5-3, King & Brater
$C_2 = 2.6$

SECTION A-A

OVERTOPPING POTENTIAL



OVERTOPPING OF DAM OCCURS AT E[illegible]

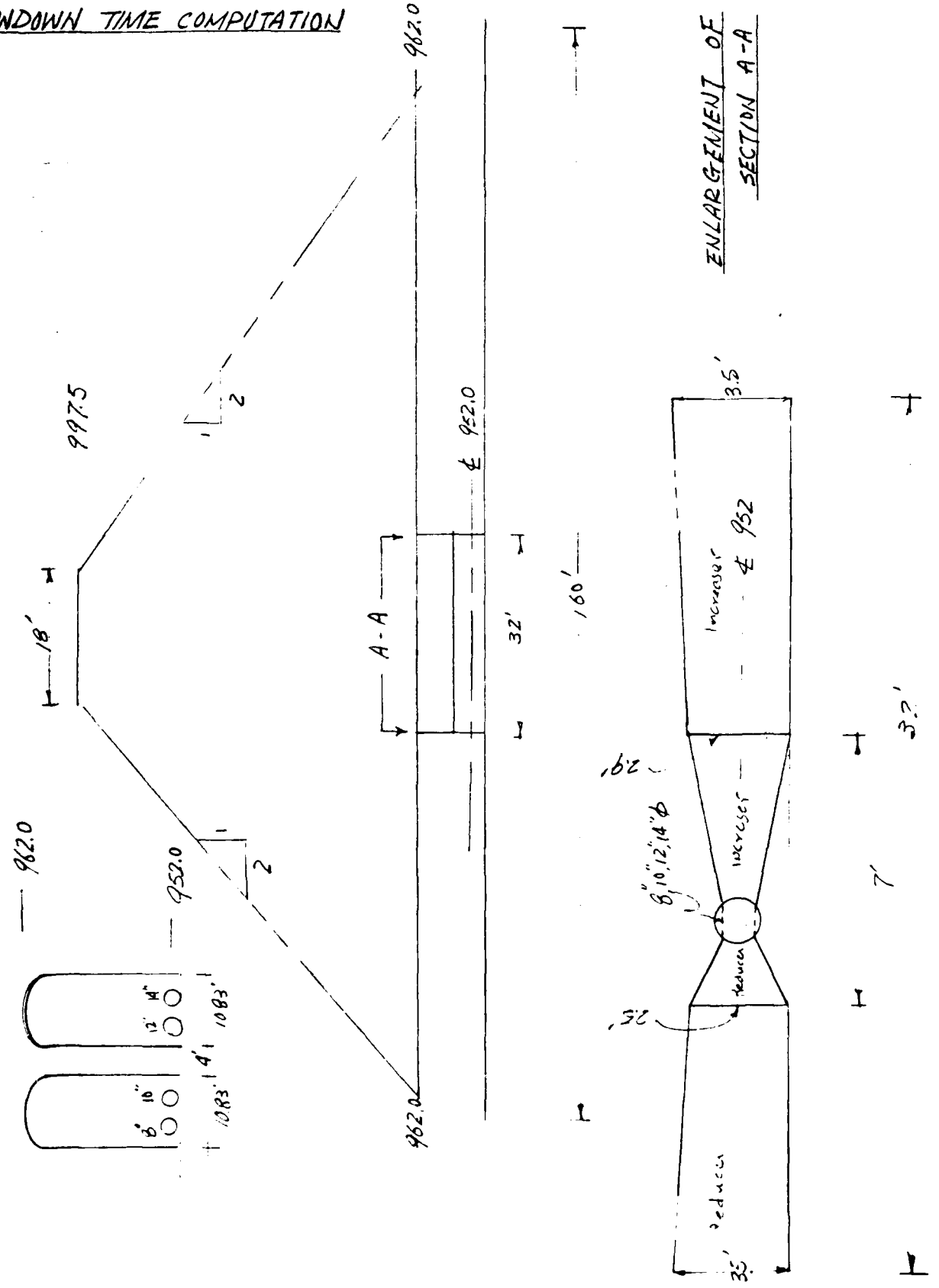
WITH Q = 10.448 cfs (~ 57% PMF)

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N.J. DAM SAFETY INSPECTION
CLINTON RESERVOIR DAM
COMPUTED BY G.L.C. CHECKED BY [illegible]

SHEET NO. 7 7 OF 9
JOB NO. 10-AB3-01
DATE 3/6/80

DRAWDOWN TIME COMPUTATION



DRAWDOWN TIME COMPUTATION (CONTINED)

EL. 992.0

EL. 952.0

8" 10" 12" 14" CIP

$K_{entrance} = 0.5$, $K_{valve} = 0.1$, $K_{exit} = 1.0$

$\epsilon = 0.00085$ and complete Turbulance

$\frac{\epsilon}{D_1} = 0.00128$ $\quad f_1 = 0.0202$

$\frac{\epsilon}{D_2} = 0.00102$ $\quad f_2 = 0.0198$

$\frac{\epsilon}{D_3} = 0.00085$ $\quad f_3 = 0.0190$

$\frac{\epsilon}{D_4} = 0.00073$ $\quad f_4 = 0.0184$

$\Sigma k = k_{entrance} + 2k_{reducer} + k_v + 2k_{increaser} + \frac{fL}{D} + k_{exit}$

$Q = A\sqrt{2gh}\,(\Sigma k)^{-\frac{1}{2}}$ where A is based on 42"ϕ

$\Sigma k_{8"} = 0.5 + 0.71 + 137 + 0.1 + 98.3 + 0.28 + \frac{.0202(32)}{3.5} + 1 = 238.07$ $\quad Q_8 = 5.0\sqrt{h}$

$\Sigma k_{10"} = 0.5 + 0.71 + 57.7 + 0.1 + 41.4 + 0.28 + \frac{.0198(32)}{3.5} + 1 = 101.87$ $\quad Q_{10} = 7.65\sqrt{h}$

$\Sigma k_{12"} = 0.5 + 0.71 + 27.0 + 0.1 + 19.5 + 0.28 + \frac{.0190(32)}{3.5} + 1 = 49.26$ $\quad Q_{12} = 11.0\sqrt{h}$

$\Sigma k_{14"} = 0.5 + 0.71 + 14.1 + 0.1 + 10.3 + 0.28 + \frac{.0184(32)}{3.5} + 1 = 27.16$ $\quad Q_{14} = 14.82\sqrt{h}$

$Q = \Sigma(Q_8, Q_{10}, Q_{12}, Q_{14}) = (5 + 7.65 + 11 + 14.82)\sqrt{h} = 38.5\sqrt{h}$

DRAWDOWN TIME COMPUTATION (CONTINUED)

Inflow = 2 cfs/mi² (9.1 mi²) = 18.2 cfs

RES. EL.	Vol. Ac-ft	AVG. Res. EL.	Q $38.5\sqrt{h}$	DRAW-DOWN TIME $\frac{24\,Vol}{1.98\,Q}$	Cul. Time (HRS)	DRAW-DOWN TIME W/Inflow $1.82\,\frac{t_i}{Q}$	Cul. Time (HRS.)
992							
	785	991	240.4	39.6	39.6	3.0	42.6
990							
	2004	987.5	229.4	105.9	145.5	8.4	156.9
985							
	1688	982.5	212.6	96.2	241.7	8.2	261.3
980							
	1572	977.5	194.4	98.0	339.7	9.2	368.5
975							
	1344	972.5	174.3	93.5	433.2	9.8	471.8
970							
	1154	967.5	151.6	92.3	525.5	11.1	575.2
965							
	607	962.5	130.6	56.3	581.8	7.9	639.4
960							
	798	957.5	90.3	107.1	688.9	21.6	768.1
955							
	363	953.5	47.2	93.2	782.1	36.0	897.3
952							

A) Time of complete drawdown with no inflow = 782.1 Hrs. ≃ 33 days

B) Time of complete drawdown with inflow (18.2 cfs) = 897.3 Hrs.
= 37 days.

```
A1                N J DAM SAFETY INSPECTION PROGRAM---GROUP XVII  10AB301
A2                N J 00314 CLINTON RESERVOIR,PASSAIC COUNTY, NJ
A3                MULT RATIO ROUTING CASE 1,PRC-HARRIS INC., WOODBRIDGE, N J
B     150         0       20                                    0       0       4
B1      5
J       1         9        1
J1    1 0         9       .8       .7       .6       .5       .4       .3       .1
K       0      LAKE                          0        0        1
K1                  INFLOW HYDROGRAPH THROUHG CLINTON RESERVOIR
M       1         2     9.10                9.10      0.8                        1
P                25      100      110       118      127
T                                                              0.8     0.08
W2             1 53
X      -1      - 05       2
K       1       DAM                          0        0        1
K1                  ROUTING DISCHARGE THROUGH DAM
Y                                    1        1
Y1      1                                                   -992.0                  0
$S      0       .23      473     1271     2246     3400     4744     6316     8004    10011
$S  10404    10796    11189    11587    14647
$E    950      951      955      960      965      970      975      980      985      990
$E    991      992      993      994     1000
$$  992 0      300      2.7      1.5
$D  997 5     2.60      1.5     1230
K      99
A
A
A
A
A
```

N J DAM SAFETY INSPECTION PROGRAM---GROUP XVII 10AB301
N J 00314 CLINTON RESERVOIR,PASSAIC COUNTY, NJ
MULT RATIO ROUTING CASE 1,PRC-HARRIS INC , WOODBRIDGE, N J

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	20	0	0	0	0	0	4	0
			JOPER	NWT	IROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS=	1.00	.90	.80	.70	.60	.50	.40	.30	.10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH THROUHG CLINTON RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	IRSDA	IRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	9.10	0.00	9.10	.80	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	15.00	100.00	110.00	118.00	127.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
	0.00	0.00	1.00	0.00	0.00	1.00	80	08	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.53

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

AD-A086 896 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/13
NATIONAL DAM SAFETY PROGRAM. CLINTON RESERVOIR DAM (NJ 00314) P--ETC(U)
APR 80 J P TALERICO DACW61-79-C-0011
UNCLASSIFIED NL

UNIT HYDROGRAPH 25 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.53 VOL= 1.00

253. 781. 1658. 2370. 2587. 2443. 2073. 1539. 1068. 771.
573. 414. 301. 219. 158. 115. 84. 61. 44. 32.
25. 18. 12. 7. 2.

PMF

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.20	1	.00	0.00	.00	8.	1.02	1.20	76	.04	.01	.03	46.
1.01	.40	2	.00	0.00	.00	8.	1.02	1.40	77	.04	.01	.03	68.
1.01	1.00	3	.00	0.00	.00	7.	1.02	2.00	78	.04	.01	.03	90.
1.01	1.20	4	.00	0.00	.00	7.	1.02	2.20	79	.04	.01	.03	108.
1.01	1.40	5	.00	0.00	.00	6.	1.02	2.40	80	.04	.01	.03	122.
1.01	2.00	6	.00	0.00	.00	6.	1.02	3.00	81	.04	.01	.03	131.
1.01	2.20	7	.00	0.00	.00	6.	1.02	3.20	82	.04	.01	.03	138.
1.01	2.40	8	.00	0.00	.00	5.	1.02	3.40	83	.04	.01	.03	143.
1.01	3.00	9	.00	0.00	.00	5.	1.02	4.00	84	.04	.01	.03	147.
1.01	3.20	10	.00	0.00	.00	5.	1.02	4.20	85	.04	.01	.03	150.
1.01	3.40	11	.00	0.00	.00	4.	1.02	4.40	86	.04	.01	.03	152.
1.01	4.00	12	.00	0.00	.00	4.	1.02	5.00	87	.04	.01	.03	153.
1.01	4.20	13	.00	0.00	.00	4.	1.02	5.20	88	.04	.01	.03	154.
1.01	4.40	14	.00	0.00	.00	3.	1.02	5.40	89	.04	.01	.03	155
1.01	5.00	15	.00	0.00	.00	3.	1.02	6.00	90	.04	.01	.03	155.
1.01	5.20	16	.00	0.00	.00	3.	1.02	6.20	91	.11	.08	.03	175.
1.01	5.40	17	.00	0.00	.00	3.	1.02	6.40	92	.11	.08	.03	234.
1.01	6.00	18	.00	0.00	.00	3.	1.02	7.00	93	.11	.08	.03	360.
1.01	6.20	19	.01	0.00	.01	2.	1.02	7.20	94	.11	.08	.03	539.
1.01	6.40	20	.01	0.00	.01	2.	1.02	7.40	95	.11	.08	.03	734.
1.01	7.00	21	.01	0.00	.01	2.	1.02	8.00	96	.11	.08	.03	919.
1.01	7.20	22	.01	0.00	.01	2.	1.02	8.20	97	.11	.08	.03	1076.
1.01	7.40	23	.01	0.00	.01	2.	1.02	8.40	98	.11	.08	.03	1192.
1.01	8.00	24	.01	0.00	.01	2.	1.02	9.00	99	.11	.08	.03	1273.
1.01	8.20	25	.01	0.00	.01	2.	1.02	9.20	100	.11	.08	.03	1331.
1.01	8.40	26	.01	0.00	.01	2.	1.02	9.40	101	.11	.08	.03	1374.
1.01	9.00	27	.01	0.00	.01	1.	1.02	10.00	102	.11	.08	.03	1405.
1.01	9.20	28	.01	0.00	.01	1.	1.02	10.20	103	.11	.08	.03	1428.
1.01	9.40	29	.01	0.00	.01	1.	1.02	10.40	104	.11	.08	.03	1445.
1.01	10.00	30	.01	0.00	.01	1.	1.02	11.00	105	.11	.08	.03	1457.
1.01	10.20	31	.01	0.00	.01	1.	1.02	11.20	106	.11	.08	.03	1465.
1.01	10.40	32	.01	0.00	.01	1.	1.02	11.40	107	.11	.08	.03	1472.
1.01	11.00	33	.01	0.00	.01	1.	1.02	12.00	108	.11	.08	.03	1476.
1.01	11.20	34	.01	0.00	.01	1.	1.02	12.20	109	.67	.64	.03	1620.
1.01	11.40	35	.01	0.00	.01	1.	1.02	12.40	110	.67	.64	.03	2056.
1.01	12.00	36	.01	0.00	.01	1.	1.02	13.00	111	.67	.64	.03	2979.
1.01	12.20	37	.05	0.00	.05	1.	1.02	13.20	112	.80	.77	.03	4331.
1.01	12.40	38	.05	0.00	.05	1.	1.02	13.40	113	.80	.77	.03	5873.
1.01	13.00	39	.05	0.00	.05	1.	1.02	14.00	114	.80	.77	.03	7452.
1.01	13.20	40	.06	0.00	.06	1.	1.02	14.20	115	1.00	.97	.03	8970.
1.01	13.40	41	.06	0.00	.06	1.	1.02	14.40	116	1.00	.97	.03	10326.
1.01	14.00	42	.06	0.00	.06	0.	1.02	15.00	117	1.00	.97	.03	11577.

1.01	14.20	43	.08	0.00	.08	0.	1.02	15.20	118	1.75	1.72	.03	12945.
1.01	14.40	44	.08	0.00	.08	0.	1.02	15.40	119	4.79	4.76	.03	15339.
1.01	15.00	45	.08	0.00	.08	0.	1.02	16.00	120	1.06	1.04	.03	18874.
1.01	15.20	46	.13	.08	.05	20.	1.02	16.20	121	.93	.91	.03	23429.
1.01	15.40	47	.37	.34	.03	148.	1.02	16.40	122	.93	.91	.03	26797.
1.01	16.00	48	.08	.05	.03	410.	1.02	17.00	123	.93	.91	.03	27803.
1.01	16.20	49	.07	.04	.03	803.	1.02	17.20	124	.73	.71	.03	27045.
1.01	16.40	50	.07	.04	.03	1144.	1.02	17.40	125	.73	.71	.03	25095.
1.01	17.00	51	.07	.04	.03	1319.	1.02	18.00	126	.73	.71	.03	22342.
1.01	17.20	52	.06	.03	.03	1354.	1.02	18.20	127	.05	.03	.03	19619.
1.01	17.40	53	.06	.03	.03	1282.	1.02	18.40	128	.05	.03	.03	17237.
1.01	18.00	54	.06	.03	.03	1127.	1.02	19.00	129	.05	.03	.03	14714.
1.01	18.20	55	.00	0.00	.00	964.	1.02	19.20	130	.05	.03	.03	11975.
1.01	18.40	56	.00	0.00	.00	828.	1.02	19.40	131	.05	.03	.03	9399.
1.01	19.00	57	.00	0.00	.00	694.	1.02	20.00	132	.05	.03	.03	7151.
1.01	19.20	58	.00	0.00	.00	554.	1.02	20.20	133	.05	.03	.03	5311.
1.01	19.40	59	.00	0.00	.00	427.	1.02	20.40	134	.05	.03	.03	3954.
1.01	20.00	60	.00	0.00	.00	318.	1.02	21.00	135	.05	.03	.03	3003.
1.01	20.20	61	.00	0.00	.00	231.	1.02	21.20	136	.05	.03	.03	2314.
1.01	20.40	62	.00	0.00	.00	166.	1.02	21.40	137	.05	.03	.03	1803.
1.01	21.00	63	.00	0.00	.00	121.	1.02	22.00	138	.05	.03	.03	1435.
1.01	21.20	64	.00	0.00	.00	88.	1.02	22.20	139	.05	.03	.03	1313.
1.01	21.40	65	.00	0.00	.00	67.	1.02	22.40	140	.05	.03	.03	1225.
1.01	22.00	66	.00	0.00	.00	63.	1.02	23.00	141	.05	.03	.03	1143.
1.01	22.20	67	.00	0.00	.00	58.	1.02	23.20	142	.05	.03	.03	1066.
1.01	22.40	68	.00	0.00	.00	54.	1.02	23.40	143	.05	.03	.03	995.
1.01	23.00	69	.00	0.00	.00	51.	1.03	0.00	144	.05	.03	.03	928.
1.01	23.20	70	.00	0.00	.00	47.	1.03	.20	145	0.00	0.00	0.00	866.
1.01	23.40	71	.00	0.00	.00	44.	1.03	.40	146	0.00	0.00	0.00	808.
1.02	0.00	72	.00	0.00	.00	41.	1.03	1.00	147	0.00	0.00	0.00	754.
1.02	.20	73	.04	.01	.03	38.	1.03	1.20	148	0.00	0.00	0.00	704.
1.02	.40	74	.04	.01	.03	36.	1.03	1.40	149	0.00	0.00	0.00	656.
1.02	1.00	75	.04	.01	.03	34.	1.03	2.00	150	0.00	0.00	0.00	612.
									SUM	25.40	22.37	3.03	397757.
										(645.)	(568.)	(77.)	(11263.22)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	27803.	17266.	5342.	2650.	397450.
CMS	.787.	489.	151.	75.	11255.
INCHES		17.65	21.84	22.57	22.57
MM		448.31	554.84	573.32	573.32
AC-FT		8562.	10596.	10949.	10949.
THOUS CU M		10561.	13070.	13505.	13505.

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HYDROGRAPH ROUTING

ROUTING DISCHARGE THROUGH DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	.0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-992.	0

CAPACITY=	0.	23.	473.	1271.	2246.	3400.	4744.	6316.	8004.	10011.
	10404.	10796.	11189.	11587.	14647.					
ELEVATION=	950.	951.	955.	960.	965.	970.	975.	980.	985.	990.
	991.	992.	993.	994.	1000.					

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
992.0	300.0	2.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
997.5	2.6	1.5	1230.

PEAK OUTFLOW IS 23352. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 20335. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 17107. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 13948. AT TIME 42.33 HOURS

PEAK OUTFLOW IS 10785. AT TIME 42.67 HOURS

PEAK OUTFLOW IS 8707. AT TIME 42.67 HOURS

PEAK OUTFLOW IS 6754. AT TIME 42.67 HOURS

PEAK OUTFLOW IS 4880. AT TIME 42.67 HOURS

PEAK OUTFLOW IS 1428. AT TIME 43.00 HOURS

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .90	RATIO 3 .80	RATIO 4 .70	RATIO 5 .60	RATIO 6 .50	RATIO 7 .40	RATIO 8 .30	RATIO 9 .10
HYDROGRAPH AT	LAKE	9.10	1	27803.	25023.	22243.	19462.	16682.	13902.	11121.	8341.	2780.
		(23.57)	(	787.30)(	708.57)(	629.84)(	551.11)(	472.38)(	393.65)(	314.92)(	236.19)(	78.73)
ROUTED TO	DAM	9.10	1	23352.	20335.	17107.	13948.	10785.	8707.	6754.	4880.	1428.
		(23.57)	(	661.26)(	575.83)(	484.41)(	394.96)(	305.39)(	246.55)(	191.25)(	138.18)(	40.42)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	992.00	992.00	997.50
STORAGE	10796.	10796.	13372.
OUTFLOW	0.	0.	10448.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	999.26	1.76	14272.	23352.	4.00	42.00	0.00
.90	998.94	1.44	14106.	20335.	3.33	42.00	0.00
.80	998.56	1.06	13913.	17107.	3.33	42.00	0.00
.70	998.14	.64	13697.	13948.	2.67	42.33	0.00
.60	997.59	.09	13417.	10785.	1.00	42.67	0.00
.50	996.87	0.00	13051.	8707.	0.00	42.67	0.00
.40	996.11	0.00	12664.	6754.	0.00	42.67	0.00
.30	995.31	0.00	12256.	4880.	0.00	42.67	0.00
.10	993.46	0.00	11372.	1428.	0.00	43.00	0.00

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 24 FEB 79